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FRANCIS BERTODY SUMNER, 1874–1945

BY R. R. HUESTIS

This brief history will be limited in its biographical and bibliographical scope. Recently both aspects of Dr. Sumner's life, the one interesting and the other extensive, have been widely published and readers of this journal could hardly have missed contact with these records. The writer had the good fortune to be in close association with Dr. Sumner during the years 1919 to 1924: first as a student and then as a student and assistant. He would like to record some of the impressions of the man himself which he obtained during this very fruitful period in Dr. Sumner's productive career.

A record of these impressions presents no difficulty save that of the confines of space. To a considerable extent Dr. Sumner represented the spirit of antithesis. He loved to question universally accepted opinion and, when it seemed good to him, to take a staunch stand in opposition to it. The average person takes some trouble to make a favorable impression at first and may not be willing or able to live up to this later. My late instructor was difficult to know and appreciate at first but gained in stature as association went on. This, then, is is written in a spirit of pleasant recollection and sincere regard.

Dr. Sumner was a man of exceptional and therefore at times rather startling candor. Almost everybody lets the obvious quietly steal past and die on occasion and the average person's lifetime is spent in ignoring truths which may prove unpleasant if publicly recognized. No truth died aborning if Dr. Sumner noticed it and believed resuscitation important. In class he was just as frank in his comments upon his own teaching as upon the commoner topic of class response. This was a surprising, and to those who were considering a scientific career, a very reassuring phenomenon. The writer was later to find that this candor has all the inclusiveness of an atomic bomb. One's own limitations would, with perhaps a little tempering of the wind to the shorn lamb, sometimes receive useful objective comment.

Dr. Sumner had a capacity for taking infinite pains. His researches were conducted with the most scrupulous care. Every measurement was made twice, the second time after an interval. Every computation was repeated. Every statement was reconsidered. Every citation was checked. This care was part of his everyday life. He found the casual inaccuracy of the average

person most disturbing and felt that we were letting slipshod methods of thinking and expression become a national trait. To have his statements to the press garbled in rewriting upset him for a day and made him reluctant to write for newspapers at all.

Naturally this care was used in the apportionment of his time: his routine was as accurate as if he had to punch a time-clock. Grants for special trips were handled with actuarial precision: materials and time all accounted for. Having had long experience with purely routine work, Dr. Sumner knew how investigators' lives may be frittered away in the gathering of data which the world may little note nor long remember. When the opportunity of directing his own investigation came he chose to work at fundamental problems. Is there inheritance of acquired characters? What is a subspecies? Can natural selection be critically tested by experiments? Why and how do organisms tend to take the color of the background?

Dr. Sumner felt that his research upon subspecies of *Peromyscus* filled his most fruitful years. Characteristically he invented the necessary techniques or adapted them to a novel purpose. He made all body measurements comparable by using only recently anaesthetized specimens, stretched uniformly on a measuring table. This method proved to be very accurate. He made measurements of pelage color—that character that beggers description—by means of a special apparatus, the tint photometer. He prepared large series and employed statistical analyses. He made a large number of experimental breeding tests. He kept different subspecies side by side in open pens for a number of generations, to test for any convergence of type.

The many reports upon the results of these researches produced some of Dr. Sumner's most important papers. Without the gratuitous assumption that they led to more recent investigations which have taken place in many parts of the world, it may reasonably be assumed that Dr. Sumner's work was an important leaven.

Dr. Sumner had strong opinions upon a variety of subjects which he would sometimes give expression to with considerable vigor. He deplored our trend in urbanization which he considered very dysgenic. He disliked commercialism which he believed was too often associated with sharp practice and exploitation. He disliked persuasive glibness and noisy patriotism or, to generalize, he disliked activities in which the charletan is at home. He viewed new activities with a skeptic's eye but was quick to accept and encourage those that became of good repute.

Dr. Sumner was quite ready to admit how much his own research had modified his opinions upon scientific subjects. The discovery that deer mice from the northern California coast had absolutely and relatively longer appendages than deer mice from the California desert quite deprived him of the faith in Lamarckism he had built upon his reading and his experiments with house mice reared in rooms of different temperature. His own brilliant tests of the escape efficiency of pursued Gambusia minnows, that are colored like the tank they are in, in comparison with fish which are not so colored, ended his skepticism of

the efficiency of natural selection. His belief that Mendelian heredity pertained to superficial characters in domestic animals was quite modified by his discovery of segregation, simple assortment and linkage in the cage-bred young of wild *Peromyscus*. Knowledge of the critical supervision that had attended them, made these results quite convincing to others.

Dr. Sumner's interest in natural history started when he was a boy. The breadth and variety of his experience in this field was exceptional even for a professional naturalist. His greatest interest was perhaps in the remarkable adaptations that organisms have been provided with for successful life in the desert. He received profound satisfaction from visisting a desert and just looking around. He felt at home there.

The last word the writer received concerning Dr. Sumner after his retirement came by the long arm of coincidence. A service man who registered in Oregon for an extension course in ornithology was in due course transferred to San Diego. Rather recently, in submitting a report upon his field observations he added this parenthetical note to the unknown reader of his papers: "While I was working on the cliffs north of the Oceanographical Station near La Jolla a man named Dr. Sumner came out to talk to me. He was so interesting and so well informed about the work I was trying to do that I want to make a note of the occurrence." The writer wishes to close with this revealing episode in the life of a great naturalist.

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AN ECOLOGICAL STUDY OF THE BIGHORN SHEEP IN ROCKY MOUNTAIN NATIONAL PARK, COLORADO[1]

By Fred Mallery Packard

The Rocky Mountain bighorn (*Ovis canadensis canadensis*) has been decreasing throughout its range for many years. Scientists and administrative officials are seriously concerned with the problem of preventing the extirpation of the animals from many regions where they form a valuable part of the fauna and their possible complete extinction as a species.

The writer began a field study of the bighorn population of Rocky Mountain National Park on March 19, 1939, as Junior Wildlife Technician in the National Park Service, and continued as Senior Wildlife Foreman, the investigation terminating on November 15, 1940. The objectives were to determine the approximate number of mountain sheep inhabiting the park, their distribution, and their ranges; to obtain information about the history of the species in the region, in order to determine the seriousness of the evident decline; to evaluate the factors effecting this decrease; to investigate possible methods of counter-

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acting or removing the major influences acting against the sheep; and to come to some conclusions regarding the probable future of the species as a member of the park fauna.

METHODS AND ACKNOWLEDGEMENTS

During the period of study, an average of five days a week was spent in the field observing the bands of sheep, watching the progress of the young, and inspecting range conditions. Other time was devoted to study of previous reports, interviewing older residents for historical material, and discussing the problem with pathologists, range management authorities, and others. The laboratories of Colorado State A. and M. College autopsied two bighorns that were found dead in the park, and its staff generously gave advice and suggestions to aid the study. The laboratories of the Division of Biochemistry of the University of California Agricultural Experiment Station analyzed water samples from several localities.

For the purposes of this study, the counts of bighorns were not restricted to the exact boundaries of the national park, but included some of the region adjacent to it on the assumption that any sheep there do enter the park itself. The important localities outside the present park boundaries included the village and valley of Estes Park, Mary's Lake, Fish Creek, and Castle, Lily, Bowen, Neota, and Iron mountains, and the area south of the present park boundary proposed to be added to the national park.

The progress of the research benefited greatly by the advice of Field Naturalist Joseph S. Dixon, who visited the park between May 17 and June 17, 1939, and again between September 16 and 29, 1939. His experience with similar problems and his knowledge of this one, based upon previous inspection of the area, supplied the key suggestions.

Acknowledgement of invaluable cooperation is extended to the entire staff of the Colorado Agricultural Experiment Station at Fort Collins, especially to Dr. I. E. Newsom, Dr. Frank Thorp, Dr. Charles H. Kick, Dr. A. W. Beem, Professor E. W. Nelson, Mr. Herbert B. Osland, Mr. Clinton Wasser and Dr. J. A. Tobiska. Dr. Frank Gassner, Parasitologist, examined fecal material collected from the range, discovering a number of important internal parasites present in the bighorns. Dr. David Greenberg, University of California, analyzed soil samples for this study.

Valuable assistance and advice were also received from Dr. Donald G. Perkins, Manager of the Veterinarian Division, E. E. Squibb and Sons, New York, and from Mr. Jacoby, of the Cudahy Packing Company, Denver. Officials of the Colorado Pittman-Robertson organization were extremely cooperative, and the coordination of the several bighorn studies being undertaken by state and federal agencies in several western states is due largely to their efforts. Mr. Lloyd Swift, of the United States Forest Service, supplied information about conditions on national forests adjacent to the national park.

Among the local residents who have contributed historical material are Mr. Abner Sprague, Mr. Shep Husted and Mr. Gordon Mace, of Estes Park; Mr. Archie Gifford and Mr. Clyde Brown, of Fort Collins; Mr. Ed Chastain, of

Loveland; and Mr. Fred Hyatt, of Drake; additional records and information were supplied by others.

HISTORY OF THE BIGHORN SHEEP IN ROCKY MOUNTAIN NATIONAL PARK

Habitat.—Wild sheep probably entered the New World over the Behring Isthmus during the Pleistocene period and became established over western North America as two species, *Ovis dalli* and *Ovis canadensis*, each with several intergrading subspecies. Other forms of bighorn are found in suitable habitat in Asia. It has been suggested (Clark, 1940) that bighorns were probably extremely abundant in western North America when the retreat of the glaciers was followed by the establishment of vast grasslands over much of the area now covered by forests. The invasion of these meadows by trees was doubtless a slow process, but eventually forests occupied large sections of the bighorn range. Being animals especially adapted to grassland environment, the sheep retreated with the loss of this habitat, parts of their population becoming separated from others by terrain which was less suited to them.

Seton estimated (1929) that two million bighorns inhabited the United States prior to 1800, and of these the Rocky Mountain bighorn was the most abundant and widespread. Central and western Colorado with its ranges of rugged mountains separated by low verdant "parks" offers a vast area of habitat ideal for bighorns. Seton believed that Colorado supported eight thousand bighorns as recently as 1922. By 1940, this number had been reduced to 2,235 (Big Game Inventory of the United States, 1941). At present, bighorns are isolated on ranges in several parts of mountainous Colorado, separated by extensive tracts of unfavorable country which they do not cross. Through the courtesy of Mr. Herbert S. Wallace, of the Colorado Pittman-Robertson organization, the writer was able to inspect the bighorn habitat of Tarryall and Ouray, Colorado, to compare conditions there with those prevailing in the national park. It is evident that the Colorado bighorns are living in regions that are dissimilar. The relative importance of the factors affecting the welfare of the sheep may therefore vary considerably in different localities.

Rocky Mountain National Park covers 504 square miles of north-central Colorado, about 75 miles south of the Wyoming state line. Thirty miles east is the edge of the great plains, the rugged foothills between ascending from 5,000 feet to 7,800 feet at the park boundary. Westward, these lower hills extend about 10 miles into the park, forming the sides of a series of parallel meadows or parks that occupy the partly filled floors of the glacial valleys. The true mountains rise from the western limit of this terrain, from 8,500 feet to above 13,000 feet, the maximum elevation being Long's Peak, 14,255 feet. The Mummy Range crosses the northeastern section of the park from east to west; otherwise the principal ranges run north and south. The Front Range, which is part of the Continental Divide, transects the park, Trail Ridge paralleling the divide on the east side. The Never Summers on the west, across the Colorado River valley, also form part of the Continental Divide. North Park lies west of the Never Summers, outside the national park.

The foothills are covered with open stands of ponderosa pine and their asso-

ciated understory of shrubs and grasses, this typical Transition community continuing into the park to 8,500 feet. The "parks" of the Upper Transition zone support a growth of prairie grasses (*Agropyron, Poa, Calamogrostis, Bouteloua*, and others), a number of exotic species introduced when ranches were established there (of which the most notable is *Hordeum jubatum*), and some browse plants, including *Salix, Artemisia, Ribes* and other genera. The adjacent hillsides are mostly covered with extensive stands of lodgepole pine and aspen and support a characteristic Canadian zone fauna and flora. The Hudsonian zone lies on the upper part of these slopes above 10,000 feet, and consists of a belt of alpine fir and Engelmann spruce extending to timberline at 11,000 feet. Above this zone stretch thousands of acres of Arctic-alpine tundra, broken by cliffs, lakes and rockpiles.

The Initial Decline.—How many bighorns inhabited the present park region when the first white settlers came here in the middle of the nineteenth century is unknown: the older residents believe there were about 4,000. Their especial habitat, then as now, was the alpine tundra of the mountain tops. Most of the bands are believed to have summered there, and, although winter conditions reduced the carrying capacity of those ranges, large areas were blown clear of snow most of the winter so that part of the summering population may have remained on the tundra the year round. A large number of sheep, however, descended in fall to the lower hills, some of them almost to the edge of the plains, few of the migrants remaining above 7,800 feet. The deep snows of the higher forest precluded their return until rather late in spring so that many bighorns actually spent much of the year on forested terrain. Naturalists familiar with bighorns elsewhere have noted that the sheep in this national park appear to utilize forested country more generally than is the habit of the species in other regions.

(1) *Hunting.*—Milton Estes records (1939) that when he discovered the valley now known as Estes Park in 1859, "there was no end to the game, for great bands of elk, big flocks of mountain sheep and deer were everywhere." The settlers depended upon the game for food, wearing the skins for clothing: before 1864 they had "made a trail to Denver, where we sold many dressed skins and many hindquarters of deer, elk and sheep." At first, few hunters visited the park, for the trail was difficult to find; but as efforts were made to improve the road, more people went to the park, and hunting for market increased.

Market hunting, combined with an apparent ruthlessness in hunting for sport, was the first severe blow the bighorns are known to have suffered. The lower mountains near the plains were the principal source of wild meat for sale, and from all accounts the killing was beyond need or reason. Fortunately for the bighorn, the larger elk offered greater profit and were more frequent targets. While elk were practically exterminated from the region, the effects on the bighorns were somewhat less drastic. Nevertheless, the bands that occupied the lower ranges part of the year were seriously decimated, and market hunting was undoubtedly a basic factor in their eventual disappearance.

Near settlements, hunting for sport further reduced the population, again affecting the migrant bands seriously. Probably few other places were so ideal for hunting as Estes Park. Recreation early superceded ranching there as the special value of the region, and during the nineteenth century outdoor recreation meant primarily the killing of animals. There has been some question whether hunting for sport has actually been as crucial a factor in the decline of the bighorn as is sometimes believed. Probably nowhere has it been more important than in this vicinity. Mary's Lake was the scene of the worst slaughter. A small outcrop rises from the meadows a hundred yards from the lake, which in former days was known as "Sheep Rock" (not to be confused with the present Sheep Rock on the Continental Divide) because bands of bighorns frequently sought refuge there. Estes states (*ibidem*), "That rock was the cause of the mountain sheep being exterminated in the Park. When we saw a flock of sheep within a mile or two of the Sheep Rock, we had a trained dog that we set on them, and they would strike straight for the Sheep Rock, then we would get the whole flock."

(2) *Restriction of the Winter Range.*—Considerable evidence supports the belief that at least until late in the nineteenth century the bighorns and other game, except some elk, left the mountains for the foothills in winter. Whether they ever migrated onto the plains is uncertain, but some did winter on the hogbacks at the mouths of Big Thompson and North St. Vrain canyons. Mr. Ed Chastain told the writer that in 1904 his father saw a small band of four to six mountain sheep near his ranch just below Big Thompson Canyon, and he himself found an abundance of sheep droppings at Union Peak (now Palisades Peak) each spring when he drove his cattle to pasture there.

Grazing of cattle and domestic sheep on the winter range, accelerated settlement of the foothills, hunting, and the construction of roads through the canyons forced the bighorns back into the mountains. Bighorns appear to be fairly tolerant of the presence of horses and cattle, but the large herds of livestock that were grazed in the foothills must have decreased the amount of forage available to the mountain sheep. Fortunately, few domestic sheep have ever been pastured in this region and the range has not been damaged seriously by them. Domestic goats have been introduced from time to time. Although it is possible that these animals brought diseases into the region, there is no evidence that they did. This influence of domestic animals was doubtless a factor of some importance in discouraging the continued use of the lower range by bighorns. Most of the ranchers liked the wild sheep, but a few resented their presence and killed them. The sheep had long used certain licks in this region which were taken over by livestock. This range was also occupied in winter by many elk and deer, and some antelope. They, too, decreased the amount of forage and used the licks.

As settlement advanced, more fences and roads were built in the lower hills and human activity increased. In spite of the tolerant nature of the bighorns, there can be little doubt that these factors served to restrict their use of this winter range. Eventually about 400 square miles of good winter habitat

lying between 5,500 feet and 7,500 feet were abandoned by the sheep. By 1900 the sight of bighorns below the canyons was an event. The species was then wintering regularly at Estes Park which had formerly been above the winter range of all but those bands that remained on the alpine summits during the winter. Today, bighorns are rarely seen east of the heads of the canyons.

(3) *Scabies.*—Market hunting and the restriction of the winter habitat had begun the decrease of these mountain sheep when another serious factor appeared. Whether domestic sheep were responsible for the introduction of scabies is uncertain. Students elsewhere have stated that this epidemic began in 1902, but several of the older residents in the vicinity of the national park believe it started much earlier, Mr. Abner Sprague dating it from 1878. At that time sheep were being grazed near Pike's Peak, in the Sapinero region, along the foothills, and possibly in the Poudre country to the north. One of these flocks may have introduced the mites, but no definite evidence has been found to prove it. Mr. Sprague states that during the last decade of the century it was difficult to find a bighorn fit to eat, for almost every sheep was covered with scabs. The epidemic raged with varying intensity until about 1903 and then began to subside rather rapidly. There appears to have been a climax about 1902, corresponding with similar epidemics elsewhere in Colorado and Wyoming. There are no valid records of scabies among the park bighorns since 1906.

The combined result of these three factors was a conspicuous decrease in the numbers of mountain sheep present in the area set aside in 1912 as a national park, a reduction especially marked in the vicinity of Estes Park and much less pronounced in the Colorado River drainage. Unfortunately, no figures are available to indicate how many bighorns were present in the park at its inception, but in spite of the decrease the number was undoubtedly in excess of 1,000.

Bighorns have been decreasing over much of the West ever since white men invaded their ranges and the early history outlined above is more or less applicable elsewhere. The reports of other investigators, working in different parts of the bighorn range, have not made it clear whether the present decrease of mountain sheep in those regions is a continuation of this early decline or whether the bighorns there, too, regained some of the numbers they had lost after the scabies epidemic died out. As far as the Estes Park region is concerned, it is possible that some of the other detrimental influences acting upon the sheep at the turn of the century would have prevented the revival of the bighorn population in numbers adequate for survival had not suitable game laws been enacted by the state and later additional protection been afforded by the establishment of most of the higher bighorn ranges as a national park.

Recrudescence.—Between 1909 and 1921 the bands increased in number and in health until bighorns were plentiful in places from which they had been nearly extirpated. Mr. Archie Gifford reports that in 1915 he saw 600 bighorns on Specimen Mountain in one day. Although the number seems large, other residents support the belief that many large bands ranged there then. It

appears now that the cessation of hunting and the termination of the scabies epidemic were not the only factors causing the recrudescence. Market hunting had taken heavy toll of the bighorns near Estes Park, but indirectly it may have benefited the bighorns that lived farther back in the mountains. Hunters obtained more profit from an elk carcass than from a sheep: therefore, while they were exterminating the elk throughout the park area, they let the bighorns west of the Continental Divide more or less alone. With the elk removed as a competitive factor from the range, the bighorns fared better than they had since they had been driven from the foothills and they showed a corresponding increase. It is probable, however, that these bands were augmented by other groups that were retreating from the disturbance of the lower habitat and that the increase was not actually as great as appeared.

The Second Decline.—(1) *Elk as Competitors.*—Unfortunately, the period of recrudescence did not last many years. By 1920, elk were again competing with the bighorns for the range. In 1912 and 1913 two small herds of elk were planted in the park, of which the second succeeded in establishing itself. During the next few years their number was too small to be of much consequence to the bighorns. By 1926 or 1927 it became evident that there was danger of the elk crowding the sheep off certain parts of their range. By about 1933 it was realized that this condition had actually arisen and that the elk were again active competitors of the bighorns. There has been considerable conjecture whether they may not have been a major factor in causing the second drop in the bighorn population which began about 1921 and became alarming in 1930. Actually, however, this competition appears to have been less influential than certain other factors.

In summer, elk and deer are to be found on the alpine meadows in some numbers, but there is such an abundance of vegetation there that it is doubtful that they have any serious effect on the bighorns. Large bands of elk migrate across the bighorn habitat, but most of them are there so short a time that the effect is negligible. In the opinion of qualified members of the park staff, during their migration season deer and elk deprive the bighorns of forage they need, an effect that may be aggravated by excessive consumption by elk and deer in summer of grasses that would otherwise be available to the sheep in winter.

(2) *Domestic Sheep as Competitors.*—As has been indicated above, the scabies epidemic at the end of the nineteenth century was probably due to the introduction of diseased domestic sheep on ranges in Colorado some distance from the national park. Few domestic sheep have been pastured on the ranges of the park bighorns. Before the national park was established, domestic sheep used the northern part of the Mummy Range and they may have injured the range there. Today bighorns are rarely seen north of Hague's Peak, except for a few on Comanche Peak.

Moderate-sized flocks of domestic sheep were placed on the northern Never Summers from time to time, especially in response to the war demand in 1917; however, by that time protective health laws were in force and no introduction of scabies resulted. Mr. Archie Gifford, who was for many years a member

of the maintenance crew of the irrigation ditch that drains the eastern slope of this range, reports that every spring during the 1920's he found dozens of bands of bighorns that had died of starvation in this region and he attributes this condition to the destruction of forage by the domestic sheep. Eventually only a remnant of the former population of bighorns remained scattered over the southern peaks of the range. Fortunately these bighorns have reproduced well and from all reports are in good health. In 1930 the national park was extended to the crest of the Never Summer and the forage grasses on this area from which domestic animals have been excluded are recovering slowly. It will be many years before the bighorns are likely to reoccupy this country in numbers.

(3) *Predation.*—Many local ranchers attribute the decrease of bighorns principally or entirely to predation. They blame cougars, coyotes and eagles especially; rarely, they speak of the former effect of wolves. This point of view cannot be entirely discounted as prejudice for many people have watched game in the park for many years and have some reasonable basis for their assertions. However, the few predators seen near or feeding on carcasses have invariably been accused of killing the sheep, which may or may not have been the case.

Years ago, when bighorns were plentiful, predators also were numerous and it is reasonable to suppose that predation on the former by the latter did occur with some frequency. From the time of market hunting until 1928, predators were killed on sight throughout the park area. Then it was realized that the park needed its predators and elimination of them was stopped. This early reduction of predators may have lessened whatever losses the bighorns suffered from predations, but reduced predation may not have been entirely beneficial. Disease was rampant among the bands and its ravages might have been partly checked if predators had been weeding out the infected sheep.

Whatever part predation played as an historical factor, its influence today is equally obscure. It is believed, on rather inadequate evidence, that about 12 cougars remain in the park. The deaths of three bighorns have been attributed to mountain lions during the past 10 years but without any valid proof to support these assertions. In 1919 or 1920 a party including Mr. Fred G. Bonfils, a co-owner of the Denver Post, saw a cougar run into a band of bighorns on Specimen Mountain and kill one or more sheep. This so aroused Mr. Bonfils that he offered a bounty on lions through the Post for many years thereafter. More recent reports are questionable, but it would not be surprising to find that cougars do occasionally kill a bighorn in the park since the sheep there are more often found among trees than is the case elsewhere in the range of the species and cougars hunt mostly in forested areas.

Coyotes have increased during the past few years and may affect the bighorns more than other predators. Coyotes have been observed trailing bands of bighorns, but no carcasses have been found that showed signs of having been killed by coyotes, although on two occasions coyote scats containing bighorn hair have been found. Some investigators elsewhere are inclined to attribute

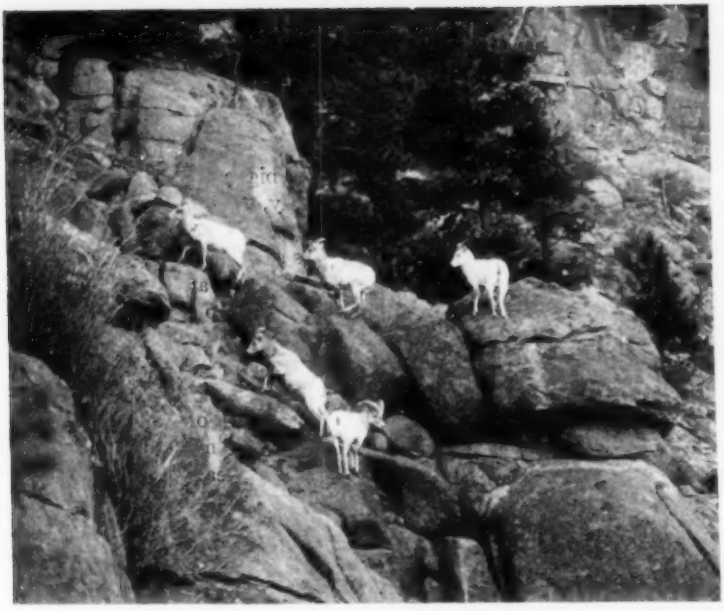

PLATE 1

Upper: One ram and four ewes climbing McGregor Mountain, May 15, 1939
Lower: Four bighorn rams eating mud at Sheep Lake, May 15, 1939

major loss of bighorns to coyote predation, but their evidence appears to the writer to be quite inconclusive.

Elsewhere, golden eagles have been known to take wild sheep lambs as food for their young. No evidence has been found to support the contention that they do so in Rocky Mountain National Park where eagles have been observed soaring low over bands that contained lambs but without paying any noticeable attention to them.

Bobcats are fairly common in the park, but again there is not the slightest evidence to connect their activities with mountain sheep.

An interesting account of predation on bighorns by a wolf was reported by Mr. Gifford. He states that a single wolf came into the Never Summers in 1919 and hunted from Lulu Pass to the Medicine Bow range during the next three years. This wolf acquired a taste for mountain sheep and was frequently seen by Mr. Gifford tracking bands of bighorns. He is sure it killed dozens of sheep because he often followed the tracks to the place where the sheep had been killed and was able to read the evidence in the snow. Mr. Gifford is a careful observer of wildlife and, although reports of wolves in the park area are very few, his statement may be accepted.

(4) *Mineral Deficiencies.*—Bighorns have been seen so frequently in Horseshoe Park for many years that the three ponds there are known collectively as "Sheep Lake." The presence of sheep at Sheep Lake is usually attributed to their desire for water and to the presence of salt blocks placed on the bench above the westernmost pond several years ago. However, while watching bighorns grazing beside the ponds in the spring of 1939, it was noticed that quantities of mud clung to the roots of the grasses they consumed. Mr. Dixon suggested that it was probably the mud they were after rather than the grass.

Further observation demonstrated clearly that bighorns all over the park avidly ingested mud. Frequently, when bighorns left the pond because annoyed by camera enthusiasts, they returned to it less than a minute after the visitors had left. By the end of the summer large patches of soil had been removed to a depth of several inches at the margins of the ponds. Although no salt blocks have been placed at Sheep Lake for several years, the bighorns have consumed more than a foot of the soil at the place where the blocks were formerly placed. On the top of Sheep Rock, on Milner Pass, ten large circular holes have been "chewed" through the volcanic mantle to bedrock by the bighorns that frequent the promontory. A sick ewe that died on May 9, 1939, chewed deep depressions in a few days in the salt block that attracted her to the Superintendent's house. A lamb, found dying on Specimen Mountain on July 5, 1939, had a few mouthfuls of grass in her rumen and with them a quantity of lava mud.

This conspicuous desire for mud as part of the diet suggested that the bighorns were suffering from a deficiency of minerals. It was impracticable to test clinically the effects of such a deficiency upon them, however, as to do so would have required the capture of live animals and the collection of dead specimens for laboratory study.

A deficiency of mineral salts in the diet will cause the death of an animal sooner than the absence of food itself. "The salts of the body direct its metabolism; they are connected with assimilation, excretion and the building up of the skeleton; moreover, they maintain the body fluids at their normal reactions —i.e., the blood and lymph at neutrality, the saliva alkaline, the gastric juice acid, the intestinal fluid alkaline depending upon the species of animal" (Smith, F., 1921). If too high a proportion of one salt is present, due to the scarcity of another salt, the proper balance is restored by the excretion of the excess of the former in the urine, but, although the balance is restored, the body is then

TABLE 1.—*Analysis of samples of water from Rocky Mountain National Park*
(Figures in parts per million)

	FORT COLLINS WATER (EXCELLENT)	LIMIT OF GOOD POTABLE WATER	SAMPLES FROM	
			Willow Park	Sheep Lake
Total solids	45	600	28	173
Volatile solids	20	100	14	78
Organic matter	trace	trace	trace	considerable
Bacteria (coli)	none	none	none	none
pH	6.5-7.5	6.5-7.5	6.3	8.3
Bases:				
CaO—lime	10	100-200	trace	light
MgO—magnesium	6	75-125	trace	slight
Na_2O—soda	4	25- 30	none	none
Total iron	none	none	none	none
Li_2O—lithium	none	trace	none	none
Acids:				
NO_3—nitrates (toxic)	none	none	none	none
Cl—chlorides	trace	20- 30	none	none
SO_3—sulfates	trace	100-200	trace	none
CO_3—bicarbonates	mostly	50-100	mostly	mostly
H_2S—sulfides (toxic)	none	none	none	none

deficient in both salts and is weakened accordingly. Thus the mineral requirements of an animal—and this applies to a growing one building up its skeleton as well as to adults—depend mainly upon the rate the various salts are excreted from the body. In cases of extreme deficiency, the skeleton itself becomes the source of necessary mineral constituents for the blood and may be so drained over a long period that it is dangerously weakened.

To justify the assumption that the character of the mud at Sheep Lake was the factor attracting the bighorns to the locality, it was necessary to demonstrate that there was at least some concentration of salts in those ponds. A sample of water was taken from the eastern pond on August 23, 1939, and sent to Dr. J. A. Tobiska, Chief Chemist of the Agricultural Experiment Station, for analysis. Another sample was taken from Fall River, a source of the water of

Sheep Lake, at Willow Park at an elevation of 10,800 feet, in order to obtain comparative figures on the purity of the stream above the ponds. Dr. Tobiska's report is abridged in Table 1.

Samples of the mud taken from the margins of Sheep Lake were analyzed by Dr. David Greenberg, Biochemistry Laboratories of the University of California, to determine what chemicals might be present in a form available to the sheep. In a letter to Mr. Dixon he indicated that the soil at Sheep Lake is fairly rich in calcium, as compared with other soils of the park. As will be discussed below, it is probable that there is a deficiency of calcium elsewhere in the soil of the park and that the bighorns really need more of that chemical; but it must be remembered that in the metabolic processes a deficiency of one chemical often indicates a deficiency of others. Although the sheep are apparently consuming calcium, it may be an entirely different chemical which they actually need.

Additional sources of salts exist in a few places on the west side of the park where part of the mantle of volcanic ash still covers the granitic and metamorphic base rock or comprises the major portion of the substratum itself. Most notable of these areas are Specimen Mountain and Sheep Rock, although other deposits cover part of Trail Ridge and form Red Mountain. Dr. Greenberg's analyses of soil from Specimen Mountain and Sheep Rock follows:

Lava mud utilized by bighorns, Specimen Mountain

HNO_3 extract		H_2O extract	
Present	Amount	Present	Amount
Iron	medium large		
Phosphate	medium large		
Calcium	medium	Calcium	medium
Magnesium	medium	Magnesium	medium
Sodium	medium	Sodium	medium
Chloride	small	Chloride	small

Volcanic ash utilized by bighorns, Sheep Rock

Iron	medium large		
Phosphate	medium large		
Magnesium	medium	Magnesium	medium
Sodium	medium small	Sodium	medium
Chloride	small	Chloride	medium

In a memorandum in the files of the National Park Service, Mr. Dixon writes, "Dr. Greenberg assured me that both the calcium and the phosphate soluble in the HNO_3 extract would be soluble in slightly lesser amount in the digestive juices of the bighorn."

Ranger-Naturalist Gene Jenkins discusses the presence of salts at this place as follows: "The bedrock of the site is essentially a mica schist with sheets and strings of granitic intrusive materials. Overlying this there was at one time a mantle of volcanic materials, of unknown thickness, the remains of which now

consist of pieces of quartz rhyolite porphyry in the regolith cover. The licks are found in a series of depressions where the soil has been largely removed; these line up along a rather well-defined zone in the bedrock.

"Two major possibilities occur: (1) The sheep may be after mineral matter which has been concentrated in the soil by decomposition of the original volcanic mantle. This, however, does not account for the localization of the licks along the zone mentioned; moreover, unless there were other constituents in the volcanic mantle than the quartz rhyolite porphyry, there is no apparent source of desirable minerals in the soil from the volcanic mantle. (2) The most logical conclusion, subject, of course, to check by chemical analysis of the bedrock and the soil, seems to be that there is a concentration of salts in this site from the weathering of the bedrock. It is significant that the sheep have stripped the soil clear to the bedrock and have exposed the irregularities of the surface, and have licked it clean in some places. The zone mentioned previously contains not only mica schist but also a harder, black mineral which is probably hornblende, and is certainly one of the amphiboles or pyroxenes; in either case, the mineral is a complex aluminum silicate of calcium, magnesium and iron, and the products of its weathering may well consist of oxides, or carbonates, or some other salt of these elements. These, it seems, are the salts that the sheep are after. The mineral is not a common one in the park, and thus there is a basis for the establishment of the zone of its occurrence as a lick."

Dr. Greenberg examined some of the bedrock mentioned in the above memorandum and expressed his conviction that the volcanic soil, and not the bedrock, supplied the mineral salts. The lick consists of at least ten circular depressions, which cross the rock from north to south in a belt 10 feet wide, and which, from the varied quantity of grass now covering them, can be stated to be the sites of the licks of former years. Apparently a new spot is chosen as a lick each year or so and the previous licks are seldom used thereafter. This year's lick measured 8 by 12 feet, and by August 3 the soil had been eaten 6 inches down to bedrock. For several years a block of salt was placed on the rock each summer. Although the practice has been discontinued, the impregnation of the soil with this salt may have some effect in attracting the sheep to the spot. However, the sheep were accustomed to visit the rock long before the salt was placed there.

The above findings suggest that a moderate concentration of mineral salts at Sheep Lake and at other favored localities appears to be the attraction that induces the bighorns to frequent these places. It must now be determined whether mineral salts are scarce or absent in the rest of the park and, if so, how the sheep previously obtained the salts they needed.

It may be noted that the principal base rock of the entire park is granite, with some associated gneisses and mica schists. The soil derived from such materials is notably lacking in mineral salts. Headden (1901, 1903) made detailed analyses of the waters of the Cache la Poudre River and its associated soils, which amplify this statement: The Poudre River obtains its water from melting snows in higher parts of the mountains, especially from the Front

Range, although it drains 1,050 square miles of mountain country. For 50 miles it flows over boulders of schist and granite, and then over gravel and sand of the same character, before it reaches the plains. Snow water is free from mineral content, and whatever mineral material the river carries through its canyon is derived from the mountain rocks. Headden determined that by far the major contributing rock was the feldspar in the granite of the Front Range. Although feldspar can supply a fairly large quantity of mineral salts when it is completely decomposed, it is especially resistent to disintegration when only partly weathered.

This study indicates a fact that is true throughout the park region: that the mountain streams have a very low mineral content, and that the salts needed by the sheep (and probably by other game animals) are not available in granitic soils, except at special locations. The following is quoted from Jenkins' memorandum: "The area now available to sheep is markedly lacking in salt deposits. . . . The nearest areas of known abundance of salts are the outcroppings of the sedimentary rocks of the foothills and the alkali deposits of the neighboring flat lands."

The answer to the second part of the question, where, if salts are scarce in the park, did the bighorns get the minerals they need when the species was abundant in the region, must be more or less hypothetical. The sheep are reduced and cannot be studied on range they no longer occupy and the investigator must depend upon the testimony of people who have long resided in such areas. A considerable quantity of such evidence has been gathered, which points to the conclusion that in former days many of the sheep that summered in the high mountains moved down in winter to the foothills to the sedimentary beds and alkali deposits.

Sedimentary deposits were available to the sheep both to the east and to the west of the present range, which is on the granitic upthrust. Such deposits may reasonably be assumed to contain licks used formerly by bighorn. Mr. Hyatt and Mr. Chastain reported that bighorns were present east of Drake, Colorado, in winter many years ago and that game licks were to be found near Union Peak and elsewhere in the lower foothills.

If the assumption is correct that a mineral deficiency is in part responsible for the present decrease in the park bighorn population, a sound remedial step is to supply minerals artificially on the range. The most practical method is to place especially prepared solid blocks of chemicals at strategic places. There are many blocks manufactured by different companies and it is desirable that tests be made to determine which ones are most suitable for use in the national park. Experiments at the Agricultural Experiment Station indicated that most of these products disintegrated quickly outdoors, or for one reason or another were not fully beneficial to domestic sheep. The only completely satisfactory blocks they found were those of the Cudahy Packing Company, of Denver, which were compounded according to a formula suggested by the Agricultural Experiment Station. These withstood all weather conditions and served to improve the health of every weakened or sick sheep that used them in a series of experiments.

The chemical formula that was thus found most efficacious for their experimental sheep was a combination of several salts as follows: crude protein, not less than 4.50%; calcium, not less than 15.00%; phosphorus, not less than 4.50%; NaCl, not more than 30.00%; and iodine, not less than 0.04%. The ingredients were steamed bone meal, potassium iodide, limestone, salt, molasses, anise, iron oxide, and copper sulphate.

During 1939 two blocks of this mineralized salt were placed on the range to determine whether the bighorns would utilize them under natural conditions. One was placed at the base of the Needles, where its use could be observed from the Superintendent's home; the other was located on Sheep Rock, frequented by bighorns throughout the year. Mr. Jacoby, of the Cudahy Packing Company, advised that a block of plain salt (NaCl) be placed with each of the mineralized blocks to provide the proper balance of body salts, and this was done.

This experiment successfully demonstrated that the bighorns would eat the mineralized salt, a band of about 20 sheep consuming 50 pounds at Sheep Rock the first year, and a slightly smaller band eating somewhat less of the block at the Needles. The NaCl was eaten more rapidly. The mineralized block withstood weathering surprisingly well, in spite of its softness, and proved completely satisfactory. Accordingly, recommendations were made to the National Park Service that this salt be placed at strategic localities on the range in an effort to restore to some extent the stamina of the bands of bighorns.

(5) *Protein Deficiencies.*—The effect of a paucity of minerals available to the sheep is not the only possible cause of decreased vitality in the population. Indeed, caution must be observed that in concentrating attention on this aspect of the problem, undue emphasis is not given to the thesis of mineral deficiency. "Single deficiencies, uncomplicated by other factors, do not usually occur under natural conditions" (Hart and Guilbert, 1933). A deficiency of minerals may be of vital importance to the health and virility of the bands, yet not be the entire factor; the metabolic mechanism can be thrown out of balance simultaneously or independently by a diet lacking sufficient variety. Only recently has it been realized that protein and vitamin deficiencies have a very practical influence on the success of range and game management policies and that they, too, must be carefully investigated.

Especially important in this respect is the availability of several kinds of proteins: an animal may eat a large quantity of a plant rich in protein, and still be unable to obtain all of the amino-acids needed for complete nitrogen metabolism. It is the quality of the protein that matters, rather than the quantity.

For domestic sheep, the diet can be regulated according to such a principle, but unless it is found advisable to feed the park bighorns artificially (a reversal of policy not contemplated as yet), the wild sheep have to eat what they can find. Nothing is known about the relative protein value of alpine vegetation so that it cannot be stated whether there is any problem of protein deficiency involved in the decrease of those bands living principally on alpine meadows throughout the year. The possibility offers a promising field of investigation.

However, considerable study has been made of the vitamin content of plants of the lower range, including several species grazed extensively by some of the park bighorns during the winter. One interesting report indicates how important this aspect of the problem may be. In Arizona, Smith and Stanley (1938) analyzed the vitamin value of blue grama grass (*Bouteloua gracilis*) at different stages of its growth. They found that young grass in August was rich in vitamin A, but that in November, when it was yellow and dry, twice as much was required to furnish an equivalent amount of that vitamin. Blue grama grass is one of the best range grasses known; if this finding can be applied to other range grasses, it may partly explain why winter game range problems are so serious.

Granting, then, that there is a strong possibility of a dietary deficiency, mineral or protein, weakening the bighorns, the question remains how it acts to decrease their numbers. Two possibilities exist: either the decreased stamina itself may cause death, or else it may provide a condition favorable to the admittance or increased activity of lethal organisms and diseases. So far, no evidence has been found that the dietary deficiency has been the immediate cause of the death of any of the bighorns from the park upon which autopsies have been performed. In every case, some other agent has been the decisive factor.

(6) *Lungworms.*—The presence of lungworms in bighorn sheep has been reported from Glacier National Park, the Sun River Preserve, Yellowstone National Park, and a number of other localities, as well as from Rocky Mountain National Park. Considerable debate has arisen about where these lungworms come from: whether they were indigenous to the bighorns, or acquired from domestic sheep where the ranges of the two forms coincided. Insufficient information is available to warrant a positive statement that the bighorn did or did not acquire worms from domestic sheep. Dr. Thorp and other pathologists at the Colorado Agricultural Experiment Station have stated that the lung worms found in the bighorns they studied appear to be a species of *Protostrongylus* distinct from that common to domestic sheep. Recently, reports have been received of the presence of another unidentified lungworm recovered from a bighorn.

These lungworms appear to be present in bighorns of normal health and to be comparatively harmless unless their numbers or activity increase unduly. The scant evidence available indicates that they are present in adults, but not in lambs before they begin to feed on range vegetation. The six-weeks lamb upon which autopsy was made July 5, 1939, contained none. It had just begun to eat grass. It appears probable that sheep acquire the lungworms while feeding on range forage, or through the mud or water at mineral licks.

(7) *Coccidia and other Parasites.*—To determine other internal parasites present in the park bighorns, fresh fecal pellets were collected from the ranges of several bands, in some cases after observations had indicated the age and sex of the individuals depositing them (Table 2). To make the information immediately available to other investigators, and to stimulate further research,

a brief report on the findings of Dr. Frank X. Gassner, Colorado State A. and M. College, in the first two lots sent him was issued by the Fish and Wildlife Serv-

TABLE 2.—*Data on collection of fecal pellets*

LOTS	PLACE	DATE	AGE AND SEX	ANIMAL'S EVIDENT CONDITION
1029	Trail Ridge	April 25	Adult males	Old, but excellent
1030	Trail Ridge	April 25	Adult males	Old, but excellent
1043 to 1046	Mount Chapin	July 10	Adults, sex unknown	Unknown
1051	Sheep Rock	July 27	Lamb	Healthy
1052	Sheep Rock	July 27	Adult, female	Parent of 1051, healthy
1053	Sheep Rock	July 27	Adult, sex unknown	Unknown
1054	Sheep Lake	June 3	Adult male	Old, apparently healthy
1031 to 1036	MacGregor Mt.	April 25	Adult females	Two pregnant, one with cough

TABLE 3.—*Parasites from sheep fecal specimens*

LOT	EIMERIA ARLOINGI	EIMERIA NINA-KHOL	EIMERIA PARVA	EIMERIA FAUERI	NEMA-TODIRUS FILI-COLLIS	OSTER-TAGIA MAR-SHALLI	OSTER-TAGIA SP.	THYSANO-SOMA ACTINO-IDES	SKRJABI-NEMA OVIS	LUNG-WORMS
1029	No parasites found									
1030	—	—	—	—	—	—	—	—	L	—
1031	H	M	M	H	M	L	—	—	—	—
1032	—	—	M	M	M	L	—	—	—	—
1033	L	M	—	—	M	—	L	—	—	—
1034	M	L	L	—	M	—	—	—	—	—
1035	L	—	—	L	—	—	—	—	—	—
1036	L	—	—	L	—	—	—	—	—	—
1043	M	—	L	—	—	L	—	—	—	—
1044	L	—	L	—	—	—	—	—	—	—
1045	M	—	—	—	—	L	—	—	—	—
1046	M	—	L	—	—	—	—	—	—	—
1051	L	—	M	—	—	—	—	—	—	—
1052	L	—	M	—	—	*	—	**	—	—
1053	—	—	L	—	—	—	M	***	—	M
1054	L	—	—	L	—	—	L	—	—	—

L = light infestation; M = moderate; H = heavy.
* = 2 free embryos.
** = 5 egg cases.
*** = 2 egg cases.

ice, in April, 1940. Since then additional specimens have been studied by Dr. Gassner and his associates.

Dr. Gassner employed a modification of Sheather's sugar-flotation method

of fecal examination, counting the number of sporocysts, egg-cases, larvae or other stages of the individual parasites present in a single drop of the sugar solution. These were scaled as follows: 1 to 5, a light infestation; 5 to 25, a moderate infestation; over 25, a heavy infestation. Results are tabulated in Table 3.

In addition, fecal specimens were obtained from an elk and deer on MacGregor Mountain, April 25, 1940, but no parasites were discovered in them. Some scavenger beetles that were eating the bighorn droppings collected on Chapin Mountain (1043–1046) were examined, but no cysticercoids were found in them.

The most important of these parasites are those of the genus *Eimeria*, the principal causal agents of coccidiosis. Four species of *Eimeria* have been identified from the park bighorns. Of these *E. arloingi* is the most dangerous, for its effects can be virulent and fatal to lambs. The less abundant *E. ninakohl* has similar effects. *E. faurei* and *E. parva* are not considered significant. Coccidial parasites are present in moderate numbers in most individuals of the many host species, and if the hosts are strong and healthy this chronic condition is harmless. The danger period is early in life, a natural immunity being developed with age. This immunity may be reached after about a year in domestic sheep, but the length of the period of danger varies with the host species. Lambs may be chronically affected, showing symptoms at about two months, but eventually die of cachexia (debility). Younger lambs may die of acute infection and show marked symptoms: extreme constipation, mucous-coated, sometimes bloody, feces, and debility. Such cases are probably due to infestation while grazing at first with the mother who has harbored the parasite over the winter.

The importance of coccidia as lethal factors in the park bighorns has not been determined. Apparently many of the adults are chronic carriers and it is possible that some of the lambs are being infected with acute and fatal cases.

The only symptom of a lighter infestation of *Eimeria* is the presence of oocysts in voided feces. Severe cases cause loss of appetite, emaciation, weakness, unkempt pelage, and constipation or diarrhea, sometimes with bloody feces. There is no rise in body temperature; often it is lowered before death.

There is no known remedy for coccidiosis that could be applied to the park bighorns. Although putrefaction is fatal to the parasites, they are highly immune to practically all disinfectants; nor are drugs or serums effective. Domestic sheep under controlled conditions can be prevented from ingesting the oocytes, but a moderate infection may be of value in providing later immunity. It is impracticable to cull the carriers among the wild bands, even if they could be identified, and the young could not be isolated from the adults. Efforts to increase the powers of resistance of the lambs will possibly save some from the fatal consequences of association with other sheep on infected range.

On April 8, 1935, Wildlife Technician Merlin K. Potts discovered the carcass

of a bighorn ram near the Endovalley campground and took the lungs to the Colorado State College of Agriculture for examination. Pathologists there isolated from these lungs *Pasteurella oviseptica*, the causal organism of hemorrhagic septicemia. The following year a dead ram was found near Mary's Lake, and examination of the lungs of this animal revealed the presence of both *Pasteurella oviseptica* and *Corynebacterium pyogenes*. This discovery of hemorrhagic septicemia in the bighorn was announced by Potts (1937).

Several sheep showing symptoms of this pneumonic infection were found during 1939 and 1940. An old ewe was seen coughing and discharging at the nose on April 20, 1939, and showed an increasing fondness for salt during the next few days. Finally, on May 9, she died about noon and an autopsy was performed by Dr. Thorp at five o'clock. The pathological examination revealed a bilateral pneumonia with edematous thoracic lymph nodes. Lungworm larvae were found throughout the lung tissue. On July 5, 1939, a band of bighorns was discovered on Specimen Mountain. Among them was a small lamb, which was obviously in poor health. When the band ran down the cliffs, this lamb remained behind and permitted close approach. It did not seem unduly frightened, but after a moment began to breathe heavily, with heaving flanks, head hung low to the ground. Eventually, it breathed more easily and turned toward the observers, a dazed look in its eyes. The writer picked it up and for a moment it lay quiet; then it kicked, urinated violently, and died. This lamb was taken for autopsy to Fort Collins, where Dr. A. W. Beem determined the cause of death as a severe case of hemorrhagic septicemia. Lungworms were not present. In addition, the intestinal tract was inflamed and the kidneys were ruptured, indicating that the animal was suffering from some form of gastric enteritis. The stomach was full of milk, which did not appear to have curdled; a few grasses were found in the rumen and with them a quantity of black volcanic soil. When first seen, the lamb walked as though suffering from rickets. Unfortunately, the skeleton was not examined.

During 1940, several sheep, including two rams, two ewes and a yearling at Sheep Lake, and a few others elsewhere, were observed that appeared to be suffering from pneumonic infections. An old ewe on Mount Baker was reported dying, presumably of this disease, but the carcass was not found.

Apparently debility caused by parasites, increasingly activated by dietary deficiencies, and particularly the irritation and congestion caused by lungworms, permit the deadly pneumonic bacteria to enter the blood stream. In cases of hemorrhagic septicemia the bacillus is *Pasteurella oviseptica*, which is present in abundance in the environment, but which requires either decreased stamina or irritation of the flesh, or both, to become effective as the agency of death. In some cases other bacilli, such as *Corynebacterium pyogenes*, may become established and produce a different kind of pneumonic condition that is equally fatal. Whatever the actual cause of death, the usual sequence of events seems to be: first, a decreased bodily stamina due to dietary deficiency and internal parasites; second, the activation of lungworms, if present, causing increased

weakness and irritation of the respiratory tract; and third, the admission of a lethal bacillus with resultant death.

Some tapeworm cysts were found in the intestine of the dead ewe, but were not identified. Dr. Thorp believed they were harmless to the sheep, the adult stage probably existing in some predator or other animal using the same range.

The park bighorns appear to be comparatively free from external parasites. One ewe was infested with a number of fever ticks (*Dermacentor andersoni*), which may have played some part in her death.

(8) *Lambing.*—The dates when the lambs are dropped in the park region are not known, but lambs first appear on the ranges with the bands of adults in late May and early June, additional young becoming evident throughout the summer. An unusual record is of a lamb reported above Cow Creek on April 15, 1939, by Mr. Stone, who has long observed bighorns at the McGraw Ranch there. It is believed that lambs are usually dropped in rugged terrain, where cliffs and small benches offer protection to the defenseless young. Frequently the assertion is made that the mountain meadows, such as Horseshoe Park and the vicinity of Mary's Lake, are lambing grounds; however, it appears that these are first visited by lambs some time after birth, probably when the young sheep are beginning to graze and need water.

Until more data are obtained in other regions, it is difficult to determine whether the production of lambs now is to be considered nearly normal or not. Evidently the lamb crop varies from year to year. In a letter of March 19, 1922, Superintendent Roger Toll noted the scarcity of lambs the preceding year. The 1931–32 Wildlife Report for Rocky Mountain National Park states that 35 to 50 ewes seen at Mary's Lake were accompanied by 5 to 8 lambs; but one-third of the ewes were estimated to have had lambs in 1932. Potts reported few lambs dropped in 1936; Freeman stated that there were "plenty of lambs" during 1937. During the two years covered by this study, from 3 to 6 lambs were usually included in a summer band consisting of 12 to 15 ewes and yearlings. There is no evidence of abortion occurring in the park bighorns. However, the band of 23 sheep, mostly ewes, seen frequently in September 1940, at Sheep Lake, was accompanied by only one lamb, although five had been there in June. In general, the production of lambs in the park appears to be somewhat lower than might reasonably be expected.

So few yearlings were observed in 1939 that the writer concurs in Mr. Potts' conclusion that a major cause of the decline has been the failure of the lambs to survive the first year. In 1940 more yearlings were discovered, although the total bighorn count was lower. This implies that previous identification of yearlings has been inadequate or that more lambs survived the winter of 1939–1940, which was relatively mild. It was possible to determine that of five lambs dropped by the band on the southern peak of Specimen Mountain in 1939, one died of hemorrhagic septicemia, with intestinal complications, on July 5, 1939. The bones of another were found at the base of a 30-foot cliff, over which it may have fallen during the winter. The remaining three were seen alive on July 13, 1940, with the band which then included six new lambs.

PRESENT POPULATION OF BIGHORNS IN ROCKY MOUNTAIN NATIONAL PARK

One phase of the problem was to determine, first, whether the decrease in the bighorn population that had been evident since the region was settled was continuing to the present, and how rapid the decline has been during the past decade; and second, how many bighorns are now in the park.

The decrease apparently is continuing, but at a slower rate. The reported intensity of the decline may be due partly to the fact that the former large bands at Mary's Lake have practically vanished in recent years. These bands were the most conspicuous in the park region. It seems to have been assumed that the other bands in the park have also suffered correspondingly. Fortunately, although some recent decrease has been evident in some other bands, it has not been by any means as marked as in the case of the sheep at Mary's Lake. Each band of sheep faces slightly different conditions and meets them with a different degree of success. Therefore, while some bands are probably

TABLE 4.—*Estimated population of Bighorns in Rocky Mountain National Park*

YEAR	ACTUAL COUNT	SUMMER ESTIMATE	WINTER ESTIMATE
1930	—	400	—
1931	287	400	—
1932	139	380	—
1933	121	360	—
1934	115	360	—
1935	111	335	—
1936	—	175	165
1937	—	175	165
1938	—	145	130

declining and may in time disappear, like the Mary's Lake band, others seem to be holding their own, or even increasing.

Until 1930, no counts were recorded, other than occasional observations of bands of sheep by the rangers. After that year, official census figures were prepared. It has been the custom to triple approximately the number of bighorns reported by the staff during the year and to use the resultant figures as the official estimate. The population estimates for the period from 1930 to 1938 are given in Table 4.

Mr. Potts made a census in 1935, the result of many field trips into the high country, in which he listed bands totalling 151 individuals (table 5). Mr. Potts believed he had seen 80 per cent of the sheep in the park, indicating a total population of 192 in 1935.

This census was the most nearly complete that had been taken and there appears to be no reason to question Mr. Potts' judgment in determining these as different individuals. The present writer believes that the proportion of the total population seen was estimated too high because in 1939 and 1940 bighorns were found in many places other than those listed above, and in greater numbers. Further, it is interesting to note that the largest band Mr. Potts

found, at Nakai Peak, was then inhabiting a region inadequately covered by me and may represent a number of sheep omitted from my census. It has not been sufficiently realized how difficult it is to find bighorns in their rugged habitat in the park and how easy it is to overlook them even when the investigator may be close to them. Any census made without the frequent use of binoculars will be incomplete; and it will improve the census if records are kept of the sex, age and, where possible, the individual peculiarities of the bands each time they are observed. During this study, effort was made to collect every valid record of observations of bighorns, not only from the park staff, but from visitors, ranchers, and many other sources as well, and much more time and attention was devoted to obtaining such reports than was possible to previous investigators.

TABLE 5.—*Potts' 1935 census of Bighorns*

	MALE	FEMALE	YEARLING	LAMBS	TOTAL
Bighorn Mountain and MacGregor Mountain	—	8	2	—	10
Endovalley	9	6	—	—	15
Trail Ridge	—	3	—	—	3
Specimen Mountain	3	18	1	2	24
Nakai Peak	—	—	—	—	60
Lake Nanita	—	—	—	—	0
Mary's Lake	1	4	—	1	6
Sheep Rock	1	1	—	—	2
Thompson	5	4	—	—	9
Lulu Pass	2	4	—	1	7
Mt. Baker	—	—	—	—	9
Needles	2	4	—	—	6
Total	23	52	3	4	151

Most of the observations are of small groups of bighorns seen at one time. By grouping the records according to localities, it was soon evident that there were certain places the sheep were frequenting. Field investigation supported this indication. Twenty-one such "territories" were discovered and others exist in the park. The total number of bighorns inhabiting each such area through the summer is included in one group in the tabulation and is given a Roman numeral.

An example of the method used in determining the minimum number of sheep in such a band follows: On June 29, 1939, twelve sheep were seen on Sheep Rock by Ranger J. Fraser. They included 3 rams, 4 ewes, 4 lambs and a possible yearling. On July 25, 1939, Superintendent Canfield and a party also observed 12 sheep there, but this time the group consisted of 7 ewes and 5 lambs. Eliminating all possible duplications, Band VIII was demonstrated to include at least 3 rams, 7 ewes and 5 lambs, a total of 15 sheep. Other observations brought the total to 18, although it is probable that the band really included more than 20 individuals.

The question arises: How coherent are these territorial bands? If individuals move from one place to another so that the population of a territory fluctuates, any statement of the composition of such a band is necessarily inaccurate, little better than an intelligent guess, and the band itself loses validity. Fortunately, the band formed in spring by the separation of most of the males from the females and yearlings appears to remain nearly constant throughout the summer. It is possible that some interchange of individuals does occur between these semi-permanent bands, but observations indicated that such a

TABLE 6.—*Bighorn Census, 1939*

BAND	LOCALITY	MALES	FEMALES	YEARLINGS	LAMBS	UNDET.	TOTAL
I	Mt. Baker	—	23	5	6	—	34
II	Red Mountain	—	2	—	1	—	3
III	Mount Howard	3	2	—	—	—	5
IV	Lead Mountain	—	—	—	1	10	11
V	Mt. Richtofen	—	—	—	—	30	30
VI	Specimen Mt., south	3	7	3	5	2	20
VII	Specimen Mt., north	5	4	—	2	9	20
VIII	Mt. Ida, Sheep Rock	3	9	1	5	—	18
IX	Hallett's Peak, etc.	—	—	—	—	11	11
X	Mount Craig, Mt. Adams	—	—	—	—	12	12
XI	Hague's Peak, etc.	—	—	—	—	10	10
XII	Mount Chapin	—	—	—	—	20	20
XIII	Sheep Lake	17	10	1	2	—	30
XIV	Mt. MacGregor	5	20	—	5	—	30
XV	Castle Mt.	1	3	—	—	—	4
XVI	Needles, etc.	5	10	—	—	—	15
XVII	Sheep Mt., McGraw's	—	—	—	1	12	13
XVIII	Mary's Lake	2	4	—	—	—	6
XIX	Moraine Park	5	2	—	—	—	7
XX	Trail Ridge	—	—	—	—	26	26
XXI	Allenspark	1	—	—	—	3	4
Total		50	96	10	28	145	329

Sex Ratios: 1 Ram: 1.92 ewes: 0.2 yearlings: 0.56 lambs, or 5 Rams: 10 ewes: 1 yearling: 3 lambs.

phenomenon is not common. Each major band has its summer territory, and diligent search will usually find the sheep there or, if not the sheep themselves, evidence of their recent presence.

The band of 20 females and young inhabiting the southern section of Specimen Mountain would have to walk but half a mile to join the band that grazes on the northern slope of Mount Ida, which latter band appeared almost daily on Sheep Rock in July, August, and September. Frequent observations of each band, however, showed clearly that these two groups remained separate throughout the entire summer (June 14 to September 28). The well-worn game trail that leads down Specimen Mountain around Sheep Rock to Mount

Ida was not used by sheep during this period: sheep tracks were never seen on it below 11,500 feet on Specimen Mountain, nor north of Sheep Rock.

Tabulated together, the counts of bighorns made in 1939 and 1940 provide a valid indication of the present bighorn population of Rocky Mountain National Park:

The 1939 count, as recorded in table 6, included probable duplications, which may be compensated as follows: (1) The Trail Ridge and Moraine Park bands may properly be combined, totaling 26, not 33, a loss of 7; (2) The bands seen

TABLE 7.—*Bighorn Census, January to November, 1940*

		MALE	FEMALE	YEARLING	LAMB	UNDET.	TOTAL
I	Mt. Baker	3	5	2	3	1	14
II	Red Mountain	—	—	—	—	—	0
III	Mount Howard	—	—	1	—	7	8
IV	Lead Mountain	—	—	—	—	3	3
V	Mount Richtofen	3	—	—	—	19	22
VI	Specimen Mt., south	7	9	3	6	—	25
VII	Specimen Mt., north	2	—	—	—	6	8
VIII	Mt. Ida, Sheep Rock	3	5	1	3	—	12
IX	Hallett's Peak, etc.	—	—	—	—	22	22
X	Mount Craig, Mt. Adams	—	—	—	—	15	15
—	Big Meadows	—	—	—	—	5	5
XI	Hague's Peak (West Cr.)	—	—	—	—	5	5
XII	Mount Chapin	3	4	2	4	6	19
XIII	Sheep Lake	12	18	3	6	—	39
XIV	Mount MacGregor	—	—	—	—	—	0
XV	Castle Mountain	—	—	—	—	—	0
XVI, XVII	Needles, Sheep Mt.	2	13	1	—	—	16
XVIII	Mary's Lake	2	5	—	1	—	8
XIX, XX	Trail Ridge	4	7	—	1	—	12
XXI	Allenspark	—	—	—	—	—	0
—	Comanche Peak	—	—	—	—	10	10
Total		41	66	13	24	99	243

Sex ratios: 10 Rams: 16 ewes: 3 yearlings: 6 lambs.

on the Needles and the McGraw Ranch at Sheep Mountain may have been identical, totaling 16, not 28, a loss of 12; (3). The bands recorded for MacGregor Mountain and Castle Mountain may total 30, not 34, a loss of 4.

The official count of 329, as used by the National Park Service for 1939, decreased by 23, totals 306. Adding 12 for bighorns seen on Long's Peak and Comanche Peak in 1939, but reported in 1940, the total count for 1939 can be stated properly to be 318, as a minimum figure.

1939 appears to have been a year of unusually favorable conditions for observing bighorns, especially near Estes Park. The 1940 count (table 7) was

less complete. Less time was devoted to making repeated counts of bands in given localities and the sheep came down to the lower elevations later in the summer than had been the case in 1939. Every opportunity was taken to verify the 1939 census, but more effort was made to obtain some estimate of the number of sheep that had not been included in that census.

Due to the larger number of females seen at Sheep Lake during the fall of 1940, it is probable that the MacGregor Mountain band of 1939 (XIV) is included, in part, at least, in the 39 recorded from Sheep Lake in 1940. Therefore, this does not represent an increase in the total population, but a shifting of habitat: undoubtedly a number of bighorns not yet recorded inhabit the Mummy Range.

Summarizing the significance of these two censuses, it was recommended that the figure 300 be used officially to indicate the approximate number of bighorns in the park, although any number between 300 and 350 would be permissible.

SUMMARY

The ecology of the Rocky Mountain bighorn in Rocky Mountain National Park was studied from March 15, 1939, to November 15, 1940. Field observations were supplemented by laboratory analyses of soil and water, autopsies of specimens, and collection of information from other observers, including early residents of the area.

Two periods of decline in numbers have occurred. The advent of white settlers caused an initial decline, due to hunting for market and sport, restriction of the lower winter range, and the introduction of scabies. Adequate protection after 1909 resulted in a recrudescence, partly an actual increase in the number of bighorns occupying the higher ranges, and partly an indirect result of the concentration of all the population on this area.

A second decline became evident in 1921 and has continued until the present. This has been traced tentatively to an apparent deficiency of mineral salts in the granitic soils of the present ranges. This is suggested by the fact that at the few places in the park where such salts are available, large quantities of soil are ingested by the sheep. The mineral deficiency may be accompanied by protein deficiencies as well. The effect appears to be a reduction in the stamina of the sheep, with an increased susceptibility to internal parasites, especially lungworms and coccidia. Further debility, and possibility irritation of the bronchial membranes by lungworms, admit pneumonic bacilli, *Pasteurella oviseptica* and *Corynebacterium pyogenes*, that effect the death of the sheep from hemorrhagic septicemia. The lack of yearlings suggests that the mortality of lambs is high. Placing of mineralized salt blocks on the range is recommended.

Although competition by elk has previously been suggested as a reason for the decline in sheep, this factor is not considered of great importance. It is doubtful, too, if predators have been of real significance in the decline.

Sex-age records of observations of bighorns over a period of two years in-

dicated that approximately 300 mountain sheep occupied Rocky Mountain National Park during 1939 and 1940, the sex ratio indicating that there were about twice as many ewes as rams.

LITERATURE CITED

ANONYMOUS. 1940. Big game inventory of the United States, 1939. U. S. Dept. Interior, Fish and Wildlife Service, Wildlife Leaflet BS-175, 11 pp.

CLARK, C. H. D. 1940. Wildlife investigations in Banff National Park. Nat. Park Bureau, Dept. Mines and Resources, Ottawa, Canada. Mimeo. Report, file U 300.

ESTES, MILTON. 1939. The memories of Estes Park. Colo. State Col. Library Bull. 6, 14 pp. Reprinted from The Colorado Magazine, vol. 16, pp. 121–132, July, 1939.

HART, G. H., AND H. R. GUILBERT. 1933. Vitamin-A deficiency as related to reproduction in range cattle. Calif. Agric. Exp. Station Bull. 560, 30 pp.

HEADDEN, WILLIAM P. 1901. A soil study. Part III. The soil. Agri. Exp. Station of the Agri. Col. of Colorado, Bul. 65, 56 pp.

——— 1903. Irrigation waters and their effects. Agri. Exp. Station of the Agri. Col. of Colorado, Bul. 83, 16 pp.

POTTS, M. K. 1937. Hemorrhagic septicemia in the bighorns of Rocky Mountain National Park. Jour. Mamm., vol. 18, pp. 105–106.

SETON, E. T. 1929. Lives of game animals. Doubleday, Doran and Co., Inc., New York, vol. III, pp. 517–573.

SMITH, SIR F. 1921. A manual of veterinary physiology. 5th ed. xv, 892 pp. New York.

SMITH, M. C., AND F. C. STANLEY. 1938. The vitamin A value of blue grama range grass at different stages of growth. Jour. Agri. Research, vol. 56, pp. 69–71.

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NOTES ON THE LIFE HISTORY OF THE FLYING SQUIRREL

BY ERNEST S. BOOTH

On April 12, 1942, the writer captured a pregnant flying squirrel in a small canyon in the Blue Mountains 8 miles southeast of Walla Walla, Washington. The animal proved to be *Glaucomys s. bangsi*, weighed 139 grams, and measured as follows: total length, 302 mm; tail, 135 mm; hind foot, 40 mm; ear, 22 mm. Twenty-nine days after she was captured, a family of three young was born (May 10). Measurements and weights were taken from the day after birth until the young were one year old. See Table 1 for record of growth.

Appearance of Young at Birth.—The new-born young were bright pink with one dark spot over each eye. There was no pigment present in the skin except where the eyes were located. The skin was transparent; the eyes were closed; the mouth, genitalia, and anus were covered over with unbroken skin. The body was naked. The patagium of loose skin was evident, and the toes were webbed. The young were completely helpless. The only sounds they made were faint, high pitched squeaks.

Growth and Development.—*Sixth day.*—Vibrissae had appeared; toes were separated.

Eighth day.—Minute hairs appeared on the nose; head and shoulders became blackish in color with a few hairs appearing on the shoulders.

TABLE 1.—*Growth records on a family of flying squirrels*

AGE	WEIGHT (GRAMS)			TOTAL LENGTH (MM)			LENGTH OF TAIL (MM)			LENGTH OF HIND FOOT (MM)			LENGTH OF EAR (MM)		
	♂	♀A	♀B	♂	♀A	♀B	♂	♀A	♀B	♂	♀A	♀B	♂	♀A	♀B
days															
1	6.0	—	—	70	—	—	22	—	—	9	—	—	—	—	—
2	7.1	—	—	73	—	—	23	—	—	9	—	—	2.5	—	—
3	8.0	6.5	5.6	77	70.5	68	24	20	22	9	8.5	9	—	—	—
5	9.5	8.2	6.8	87	83	74	24	21	23	10	10	9	4	4	4
8	10.65	9.2	7.5	97	90	83	33	33	25	10.5	11	10	6	6	6
9	11.1	9.7	7.5	100	93	88	37	34	28	12	11	10	7	6.5	6
11	12.9	11.2	8.9	107	104	94	38	35	32	13	13	12	7	7	7
14	15.4	13.8	10.5	111	108	96	40	39	34	15	14.5	12	7.5	7	7
15	17.1	15.0	11.6	118	111	100	42	40	34	15	14.5	12.3	7.5	7.5	7
16	17.5	15.3	12.0	120	115	113	44	40	35	15	15	14	7.5	7.5	7
18	19.4	16.5	13.8	128	119	117	48	48	41	19	18	14	9	8.5	7.5
21	22.0	19.3	15.9	130	126	117	50	48	43	19	19	16	9	9	7.5
23	22.8	20.5	16.1	135	128	117	54	50	45	19	19	18	9	9	8.3
25	23.6	20.6	17.3	142	135	120	55	50	48	22.5	22	19	10	9	9
32	26.0	23.5	19.8	152	143	138	66	62	57	27	27.5	22	14	14	12
35	27.1	24.7	21.1	157	154	141	70	68	61	31	26	24	14	14	13
37	26.7	24.9	21.8	160	155	144	70	68	62	31	27	25	15.5	16	13
39	27.9	25.7	22.3	164	156	145	70	70	63	32	29	27	17	17	16
41	29.2	26.4	23.5	167	165	146	72	70	64	32	29	27	18	17	16
44	30.0	27.3	24.9	172	170	150	75	71	65	32	30	30	18	17	17
49	34.0	28.0	25.5	173	172	154	77	73	71	32	31	30	18	18	17
56	32.0	28.9	27.8	178	174	165	79	75	71	32	31	30	18	18	17
64	30.5	27.0	27.0	188	178	172	84	78	76	32	31	30	18	18	17
71	37.2	34.8	32.5	196	178	176	92	88	86	33	32	32	18	18	18
78	41.0	36.3	35.2	207	197	195	97	95	94	34	33	33	18	18	18
85	42.5	35.5	34.0	212	198	200	100	96	98	34	33	33	18.5	18	18
92	45.0	42.0	38.0	213	200	202	101	100	100	34	33	33	18.5	18	18
123	58.0	56.2	51.4	220	218	216	106	104	103	35	33	33.5	19.5	18.5	18.5
153	72.3	70.3	66.5	243	235	234	113	107	105	36	34	34	20.5	20	19
184	88.0	86.5	80.0	270	255	250	120	112	108	38	35	35	22	21	20
214	82.0	88.8	72.2	270	264	255	120	117	110	38	36	35	23	22	20
245	83.0	92.0	56.0	270	268	255	120	122	112	38	36	35	23	22	20
276	97.0	102.3	91.2	275	270	258	127	125	113	38	36	35	23	22	20
304	107.5	103.0	92.0	277	272	260	128	126	115	38	36	35	23	22	20
335	116.0	96.0	90.0	279	272	260	128	126	115	38	36	36	23	23	21
365	104.0	84.0	76.0	282	272	263	130	127	116	38	36	36	24	24	22
Size of mother—															
	139			302			135			40			22		

Eleventh day.—Back and sides became pigmented with brownish black color; fine hair appeared on most of the body; shoulders covered with dark black hairs, and the back and sides with lighter brownish hairs.

Fourteenth day.—Top of head and shoulders covered with thick brownish

black hair; sides of the shoulders covered with light brown hair; lips covered with long whitish hair; vibrissae whitish; claws became evident.

Eighteenth day.—Head and shoulders now nearly brownish, but some black hairs present; almost all of the back and sides now covered with hair; feet well developed with long toes and claws. The young moved about rather awkwardly by crawling. The eyelids show signs of widening at the point of separation; genitalia still covered over smoothly.

Twenty-first day.—Hair brown halfway back between the shoulders and the hips.

Twenty-third day.—Posterior part of the back blackish; feet, tail, and patagium covered with black hair.

Twenty-sixth day.—Two incisors appeared in lower jaw.

Thirty-second day.—Eyes opened in the male and in female A, but are still closed in female B. Dorsal parts of all three resemble the mother, but the color was somewhat more blackish and the fur finer and not so long. Ventral parts covered with fine whitish hairs.

Thirty-fifth day.—Tails now appear flat; vibrissae were long; ventral parts well covered with hair.

Forty-first day.—Young could support their weight on their legs, so they walked for the first time. The tail was well covered with fur and quite flat in appearance.

Forty-seventh day.—Young ate solid food. Each nibbled on a few carrots.

Beyond forty-seven days.—Growth was steady up to the age of one year, when they seemed to be almost adult. It is impossible to say when the young reach adult size, for caged specimens may not react normally in this respect. At one year none of the young was as large nor as heavy as the mother, but a glance at the chart (table 1) shows that they were nearly full grown. Perhaps normal animals in the wild would be full grown at one year even though caged animals were not quite adult in size. A study of the chart will show that growth in weight and size was quite steady, although there were a few times when one or more of the animals lost weight. In one case (between the eleventh and twelfth months) the weight loss was quite marked in all three animals.

Weaning.—The date of weaning could not be determined exactly. At 65 days the young showed evidence of being weaned, although they still nursed occasionally even after 85 days. In the wild state it would be unlikely that they would nurse as long as they did in the cage. Weaning at 65 days therefore seems likely.

Gestation.—While the gestation period could not be determined in this case, it was 29 days from the time the female was captured until the young were born. The gestation period, then, is not less than 29 days.

Food.—This family of squirrels was fed a variety of food such as wheat, corn, rolled oats, apples, carrots, lettuce, walnuts, and Ralston-Purina "Dog Chow." On this diet their teeth never seemed too long for normal feeding.

Flying.—The young first glided at the age of three months. When four months old they had become quite skilled at gliding and also at running and climbing.

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BEAR FACTS

By Bertrand E. Smith

The story really begins on the morning of January 27, 1943, when, as manager of the Moosehorn National Wildlife Refuge, I had to blaze and lay out the trail for a logging road through Mahar Brook Valley, a southern section of the refuge. I was accompanied on this trip by Harold Stanhope, one of our patrolmen, and Chief Warden Lloyd Clark, who frequently makes trips with me for the purpose of obtaining information on wildlife matters. In order to get a good location for the road, we had to separate—at times to a considerable distance—and this forced us to shout instructions back and forth, making an unusual amount of noise. As I was going through a scattered growth of black spruce on a heath at the head of Mahar Brook, I all but stepped upon the back of a very large black bear (*ursus americanus*). Without a perceptible sound, the bear was up and away.

Before she was out of sight and I had fully recovered my senses, I heard a chorus of pitiful cries coming from under the drooped and snow-covered branches of a black spruce tree. At once I parted the boughs, and in the middle of what looked like a large bird's nest I saw three dark brown bear cubs about the size of gray squirrels. If I had not seen the old bear leave her nest and run away, it would have been rather difficult to identify the little animals from their looks or from the appearance of the den. They were so tiny that no one, unless intimately acquainted with the black bear, would have taken them for bear cubs. The mother with her warm body and fur coat had gone, leaving them almost without protection against a sub-zero temperature. Their plaintive cry was not unlike that of a small child. I called the men over and showed them the den, and told them not to go near it nor touch the cubs for fear the human scent would alarm the mother and cause her to desert the family. We thought surely the mother would return as soon as we were gone so after a brief conversation we left for headquarters at 11 a.m. We intended to have lunch, get our cameras, and return to the den for pictures of the old bear in her den. When we arrived home at noon, the thermometer registered −4°F.

Thinking the light for taking pictures would be best about 2 p.m., we returned to the den, arriving there 5 minutes before the hour. To our complete astonishment and dismay, the mother had not returned. A most pitiful sight met our eyes. There in the bottom of the nest were three little forms stretched out in seeming death. We thought they were dead, but we were taking no chances, so we tenderly picked them up, tucked them inside our shirts, next to our bodies, and carried them from the woods to where my wife and Patrolman Dudley's wife were waiting in the car. The heater was put to work, and the "lifeless" bodies were placed on a soft woolen blanket where the warm air from the heater would best strike them, hoping they would revive.

In a few moments Mrs. Smith thought she saw one of the cub's paws twitch. All eyes were focussed on that cub while we anxiously awaited further signs of life, and when it did manifest itself we were overjoyed. Soon after signs of life showed in the first little cub, the others revived also.

Our next move was to take the cubs to our home where it was warm and they could be properly tended. None of us had ever taken care of bear cubs before; the only thing we had to guide us was a little common sense. After a brief conference, Warden Clark was dispatched for a baby's nursing bottle and nipple to be used in feeding the cubs. When Clark returned, we diluted cow's milk 50 per cent with water, at about body temperature, and fed the cubs through the nipple. It was necessary to force the nipple into their mouths. Then by placing my thumb under the chin and the fore fingers over the bridge of the nose, I was able to depress the nipple and force the milk into their mouths, which were very large—larger than any other part of their bodies in proportion. After this feeding the little animals were examined, named, weighed, measured and photographed. There were two males and one female. We named them Amos, Andy and Madam Queen. Amos, 9 inches long, weighed 1 pound and 4 ounces; Andy and Madam Queen were each 8½ inches long, and each weighed 1 pound and 2 ounces; the combined weight of the three cubs was 3 pounds and 8 ounces. Their bellies and under parts were absolutely bare; the hair on their backs was just discernible; over most of their bodies was a thin, whitish scale, similar to dead skin on a man's face after a bad sunburn. An examination of their mouths showed no teeth, and this, together with the appearance of their feet, indicated to me that the cubs were newly-born, a few hours old at most.

All during the first night the cubs cried pitifully because they were frost bitten. Madam Queen, for some reason, was unable to survive the long period of exposure at sub-zero temperature and died in Mrs. Smith's hands the following afternoon. We were afraid we would lose the others, but they lived. In a few days the tips of both their noses came off, leaving them raw and bleeding. Andy lost all the toes and claws on his left paw and some of those on his right, while Amos lost two toes from his right paw and some from his right hind foot. After the cubs had had several feedings of a 50 per cent mixture of cow's milk and water, the hair began to show a little; that near their muzzles and noses grew in dark brown.

I had good help in caring for them. When my bird dogs, a pointer and a springer spaniel, first saw the cubs, either the noise or the odor of bear frightened them. After a little coaxing, however, the dogs got over their fright and adopted the cubs. The dogs kept those cubs clean and cared for them in much the same manner a cat does her kittens, giving them tongue baths several times daily.

At first we kept the cubs in a small wooden box, 2 feet long, 14 inches wide, 12 inches deep, with holes in the side for ventilation, and the bottom covered with part of an old woolen blanket. This box was placed on the floor of a wood storage closet next the chimney adjacent to our living room. There are four doors between where the cubs were kept and our bedroom, but with all doors closed we could hear them crying at night. For the first few days they cried almost constantly with the pain of their frost bites.

To keep the cubs from getting out of their box, I placed Hammond's World Atlas, weighing about 10 pounds, over the top of the box. When the cubs were

about 2 weeks old, they became so strong that they pushed the Atlas from over them, and within a short time we had to add the weight of several other books. When they were about 2 months old, a weight of 36 pounds was necessary to hold the cover over them. After this, they pushed apart the sides of the box. This seemed remarkable when one considers that they had little or no use of their hind legs: they had surprising strength in their fore legs.

The cubs' hind legs were practically useless for a considerable period, even after their eyes opened, and about the only use they had of them was to push themselves ahead. One of the first things I noticed when feeding them was that they were as helpless as new-born babies. When they tried to get anywhere, they pushed themselves along very much like a baby first starting to creep. When they were first able to crawl, it was never in a straight line, always in a circle, and then they toppled over helplessly.

On February 22, Andy's left eye opened. The other did not open until February 25th. I thought the eyes of the other cub would never open, nor did they until March 5—10 days later than Andy's. Their eyes looked like little beads of jet. To feed the cubs we held them in our laps and under a strong electric light: this may have caused their eyes to open sooner than they would have otherwise under normal conditions in the den with their mother, where it is always dark.

After their eyes opened, considerable time passed before the cubs could stand on their feet, and even then they walked in circles and toppled over at the least provocation. I watched their development very closely and came to the conclusion that cubs, born while their mother is asleep, nurse her until she awakens in the spring, and that the weakness in their hind legs is Nature's way of preventing them from crawling away from their mother during this period. That their eyes do not open for so long a period supports this theory.

When I consider that I daily fed those cubs 1½ pints of milk, diluted with water at the beginning, and by the last of April each was drinking 3 quarts of whole milk besides half a can of evaporated milk and 2 cupfuls of cooked oatmeal every day, I can readily understand why they are so small at birth. Larger cubs would consume too much food during the inactive period of the mother. In view of the amount of food necessary to feed three little cubs for about 2 months, the mother's milk must be copious or highly concentrated. Cubs nurse their mother for the first year and den with her the following winter. The first season she teaches them how to feed and care for themselves, so that a bear usually does not breed oftener than every 2 years.

Soon after the cubs were able to get about on their four feet, they got into so much mischief upstairs that I had to take them to the basement. When it came time to eat, they let us know by crying, and if the basement door was not closed and bolted, they would get it open and come bouncing up the cellar stairs. Andy had no regard for silk stockings, and when Mrs. Smith was near, he would hug his arms around her leg, cry, and try to climb up. Amos did the same with my pants leg, but with less damage. Sometimes I would feed both of them, a cub and a nursing bottle in the hollow of each arm. Even when

Andy was nursing his bottle, if Mrs. Smith came near he would stop, listen a second, scramble out of my lap, and go to her to be taken up and petted. He was perfectly happy to sit on her shoulder, and, if she permitted him, cuddled his head on her neck. He would make funny noises, impossible to imitate and very difficult to describe. It was rather a broken hum, something like the letter "N" repeated in rapid succession, soft and musical. From the very beginning of feeding, they would sometimes stop nursing the bottle, take my finger or any part of warm flesh, and mouth or suckle it. While doing this, they would make that queer little broken hum I have tried to describe, and at the same time work their front legs and feet much like a kitten does when it contentedly purrs and kneads its claws.

As they grew older, their feeding became more and more of an interesting experiment. The amount of milk each cub consumed at a feeding was almost unbelievable, almost equal in bulk to their entire body size. Many times I had to look twice to see which was the larger, the bottle of milk I was to feed or the cub. They were fed three times daily, and when they had finished, the milk would run out of their mouths and their little bellies would be as tight as drums and as round as pumpkins. I tried to get them to eat solid food, such as raw or cooked meat, fish, and about everything edible I could think of. All efforts to feed them something other than milk or milk with a little cooked cereal were unavailing. When they wouldn't eat honey, I was surprised. Evidently their taste for sweets develops later.

They would follow me everywhere I permitted, and I never saw them go to the wrong side of a door in an attempt to open it. They had some way of knowing which was the right side and confined their efforts to that side. One day when we were having lunch and thought the cubs were locked in the cellar, I heard Amos come bouncing up the stairs and directly to me. He was pleased as could be to find me, but I took him under my arm and down the cellar stairs, where, to my surprise, I found the door bolted. I searched to determine how he had gotten out and finally discovered that he had managed to get onto the top of our hot-air furnace, crawled over the top onto one of the hot air pipes leading in the direction of the door, where he pulled open a small screen built in over the cellar door for ventilation, crawled through that hole and then, I suppose, dropped from there to the floor below. A most remarkable and clever stunt for even a small child.

They cut their teeth just like a child, only they were sharper and grew more rapidly. A few days after I found the cubs, the teeth started to show and in about 2 months they were good-sized. I do not remember that they had any little incisors, however, while I had them. They knew what their teeth were for all right, and once or twice Amos bit Mrs. Smith sufficiently to bring blood. They both tried to nip me on several occasions, and when they started to nip, I talked to them and cuffed their ears. The harder they bit, the harder I cuffed. They would look up into my face, their little black eyes scintillating deviltry and temper, and make a little noise like a whine: all the time they would have my fingers or hand firmly between their teeth, but for some reason or

another, they never shut those powerful little jaws, and finally they would let go. The only time I saw them really show temper or fight was over food. Amos was a little the larger and was the boss. I fed them in separate dishes, but Amos would hurry and eat the bulk of his food and immediately run over to grab Andy, strike, kick and bite, and drive him away, and proceed to eat Andy's food if I were not there to protect him. I was never able to feed them by dish alone. They always had to have their nursing bottle afterwards. Finally they got so they could take the bottle in their own front paws, lie on their backs and nurse it. They would get so full their little bellies would almost touch the flocr.

In the first warm days of spring I took them out of doors. They were frightened at first, but soon learned to love it. They followed me around like two dogs. Andy had trouble in climbing trees as he had no claws on his left paw, but it was natural for him to try. Often he would lose his hold and get a bad fall. After they had been out of doors a time or two, I noticed they would sit among small bushes and reach around with their fore legs and pull the bushes to them, biting off and eating the new, tender buds and leaves. They also ate tender blades of grass.

I believe that in their natural environment black bears eat very little meat. I have seen where black bears killed sheep and carried off pigs, and I have also seen them come at night into an orchard where sheep were pastured, walk past them, and fill up on apples. Nor did they harm the sheep so long as there were plenty of apples. Last November (1944) near the refuge a black bear tried to take a pig weighing 300 pounds out of its pen and carry it away. The farmer heard the pig squealing and drove the bear away, but the pig had to be killed because of its wounds.

The dogs and the cubs never played together much. The bears were too rough. Everytime a dog ran up, the cub would stand on its hind legs, drop its front legs straight down to its sides, and stick out its chin as much as to say, "Come on, tackle me if you dare." The first time this happened, the pointer apparently didn't comprehend the menacing attitude, but when the cub grabbed him around the neck and began to hug, claw, and bite, the dog got the idea and thereafter was more cautious. The cubs at this time were so strong in their front legs that I had to exert all my strength to pull their front legs apart once they had started to hug anything.

They were mischievous and got into all sorts of trouble. When they got into the living room they turned over chairs and other furniture. One day we missed them and hunted everywhere. Mrs. Smith was positive they had strayed away into the woods and would surely get lost. I didn't think so, but I was worried. About supper time I heard Mrs. Smith calling from the cellar that she had found them. Sure enough, there they were, cuddled together in the bottom of the washing machine. The lid almost covered the machine, and I don't know how they got inside, unless they were playing on top when the cover tipped.

I have never seen animals show so much affection as those cubs. Almost any animal responds to kindness and will show affection to a certain extent,

especially at feeding time, but these cubs wanted to be with us constantly. If I sat down, they would run and get into my lap instantly. Andy would forsake either his food or me for Mrs. Smith. She brought him up, and he was her cub.

One day the patrolman removed the storm windows and left the step ladder leaning against the house under the open kitchen window. Both cubs had been for a walk with me, and when we came around the house I saw Andy bound ahead toward the step ladder. As he had never seen one before, I wondered what he would do. To my surprise he went up that ladder and climbed through the window just as if he had always been in the habit of doing it.

We both grew very fond of these little animals, but they became too much care, so we decided to let them go back into the woods. They were too young to release at the time, so we arranged to put them into the care of the Superintendent of the State Game Farm, with the understanding that as soon as they were able to care for themselves they would be taken to the wilderness and liberated. On May 17, 1943, Amos and Andy were put into a wire-covered crate and shipped to the State Game Farm at Gray, Maine.

We had kept a close watch on the bear's den to find out if she ever returned, but we never found any tracks in the snow to indicate a visit.

We had to cut and remove several of the limbs about the nest in order to get pictures of the den. Although she had been denned a considerable time, there was no dirt or excrement of any kind in the nest, except the fecal plug left at the time of her departure. This was dark greenish brown in color, about 5 inches long, and 1½ inches in diameter.

The heath at the head of Mahar Brook is one of the most isolated places on the Refuge. In Maine a heath is a dry bog that probably was once the bottom of a lake, into which has grown a stunted and sparse growth of black spruce and larch. This bear prepared her winter quarters under the drooped and spreading branches of a small black spruce next to a dense softwood growth of spruce and balsam fir at the northern end of the heath. The spruce was not a large one—approximately 10 inches in diameter—but it had thick foliage and many limbs. The lower branches, 11 feet long, drooped from about 3 feet and almost swept the ground. Under these spreadng branches, next to the trunk, she had scooped out with her paws a small depression in the ground and lined it with sweetfern (*Kalmia* sp.) and leatherleaf (*Chamaedaphne calyculata*). She also used the small and soft tips of the spruce boughs. She seemed to prefer the leatherleaf to any other material, and it was woven into the nest as cleverly as the expert fingers of a woman could have done it. In other words, the old bear didn't just gather the material for her nest and dump it in a pile under the spruce and call it a nest. She fashioned and wove the material from the bottom up, and when it was finished it was a soft and springy bed, measuring on the inside 34 inches wide and 16 inches deep. For a roof she bent down the lower branches of the tree and held them there by weaving through the branches some of the material she used in building the den. The ends of the limbs she buried in the ground, piling on top several broken lengths of a decayed gray

birch tree and other material. The material for her den she probably gathered close by, but we saw no evidence of this. The gray birch she may have carried a considerable distance as none grew in the immediate vicinity. The ends of the material used in building the nest looked as if they had been bitten off.

The completed job was such that the snow from each storm would drift and bank against the back and sides of the den, thus giving added protection against the cold north winds. On the southwest the den was left somewhat open to serve as a ventilator and to permit the afternoon rays of the sun to shine in and help keep her warm.

The den was a work of art, and the more closely we examined it, the more we realized how very little most of us know about nature. In choosing a location for her den, in taking advantage of everything available that would serve as protection against the long, cold days of winter ahead, in preparing a place where she could sleep and have her young in comfort and solitude, the old bear used better judgment than anyone would have expected of her.

Moosehorn National Wildlife Refuge, Calais, Maine.

DOES THE JAGUAR USE HIS TAIL AS A LURE IN FISHING

By E. W. Gudger

That the jaguar fishes by the simple scoop of a paw is abundantly attested by the eight accounts quoted in my earlier article, "Cats as Fishermen" (Natural History, 1925). Furthermore, in books, in letters, and by oral communication from those who have explored in South America, there have come other statements. But since the matter is sufficiently attested and since these statements lack details, they are not inserted here. However, the alleged use of the tail as a lure in fishing is a new matter and one that deserves careful consideration. Herein follow the accounts that have been collected.

THE ALLEGATIONS AND THE MEN WHO MADE THEM

The earliest notice of this habit seems to have been made by the Swiss naturalist, J. R. Rengger, who lived in Paraguay for eight years. He wrote in 1830 (Naturgeschichte der Saeugethiere von Paraguay, p. 169) that the jaguar is said to lure the fishes by tapping with his tail on the surface of the water. When they come up, he snatches them out with his paw. Rengger apparently never saw this, but had the account from the Indians, as did the next writer.

This is no less an authority on the natural history of the Amazon Valley than Alfred Russell Wallace, who spent the years 1848–1852 in exploring the Valley and in gathering data for his "Narrative of Travels on the Amazon and Rio Negro" (London, 1853). On page 455 he wrote: "The jaguar, say the Indians, is the most cunning animal in the forest; he fishes in the rivers, lashing the water with his tail to imitate falling fruit, and when the fish approach hooks them up with his claws." Here is given not merely the action of the tail but an explana-

tion of how and why it has come to be so used. It is unfortunate that Wallace does not indicate the particular regions where he heard this story.

The next account is from a book, "The Amazons," by R. Stewart Clough, published at London without date but probably about 1873. Clough made a missionary journey on the Amazon from February, 1872, to January, 1873. In that part of his journal written at Villa Bella, near where the Madeira enters the Amazon, he states (p. 70) that: "Fish abound in surprising variety and numbers, and here, too, the jaguar may often be seen engaged in piscatorial exercises, as he draws his tail backwards and forwards in the water till approached by his finny prey, when with lightning speed his sharp-clawed paw grasps the prize." Clough does not indicate the source of his information, but he apparently states it as a fact.

The next reporter is Herbert H. Smith, whose experiences in Amazonia covered four years. He went to Brazil in 1870 as assistant to his teacher, Prof. C. F. Hartt. In 1874, he returned to Brazil to collect and study animals. Three years were spent in the vicinity of Santarem and in exploring the Tapajos and the adjacent northern tributaries of the Amazon. The observations and experiences of these years are embodied in his interesting and valuable book, "Brazil, the Amazons and the Coast" (New York, 1879). In this he states that the jaguar belongs in the lowlands where his prey abounds, and on page 104 he writes thus of its tail-fishing proclivities:

> The spotted Jaguar belongs here [on the rivers of Brazil] by right; he is a fisherman as well as a hunter, and . . . you never find him far from water. The Indians have a curious story about his fishing. The Jaguar, they say, comes at night and crouches on a log or branch over the water; he raps the surface of the water with his tail gently, and the *tambakis*, or other fruit-eating fish come to the sound, when he knocks them out with his paw. I do not take it upon myself to say that this story is true, but I have heard it from all sides, and from persons who aver that they have seen the fishing.

Here is a reiteration with added elaboration of the explanation given by Wallace of why the fishes assemble when the water is disturbed by the jaguar's tail. The *tambaki* fish (designated for the first time), accustomed to swarm at the surface when their favorite fruits disturb it by falling from the overhanging trees, come to the tail-lashing seeking food but there meet their doom.

Our next reference takes us forward 42 years and far into northwest Brazil to the Caiary-Uaupes headwaters of the Rio Negro. Here the distinguished ethnologist-explorer, Theodore Koch-Grünberg, heard of this kind of fishing. He states ("Zwei Jahre bei den Indianern Nordwest-Brasiliens," Stuttgart, 1921, p. 250) that "I was repeatedly assured, by both Indians and reputable white settlers, that the jaguar sits in the moonlight on the beach splashing the water with his long tail and throws the up-coming fish out on dry land with one stroke of his broad paw." He adds that "This is not altogether impossible."

The last author to be quoted is the well-known Brazilian ichthyologist, Agenor Couto de Magalhaes ("Monographia Brazileira de Peixes Fluviaes," Sao Paulo, 1931, p. 205). He identifies the Tambaki (English) or the Tamba-

quy (Brazilian) fish as belonging to the Characin genus *Myletes*. Here is what he has to say of fish, fruit, and jaguar:

> The Tambaquy fish feeds on the fruits of various trees and bushes . . . which grow along the banks of the streams and fruit during high water. They are collectively called Tambaquy fruits. Pulled at when ripe by birds, they often fall into the stream, producing the characteristic sound of a small spherical object falling into the water [a plop]. At the sound, the fish which are swimming around, hoping for falling fruits, are attracted and, with the voracity which characterizes these fish, swarm around the fruits and swallow them.
>
> The Indians take advantage of this habit to catch the Tambaquy fish—if we may give credit to their stories. . . . They allege that the oncas (jaguars) were their teachers in this kind of fishing. The jaguar [they say] places itself on a leaning tree trunk at the edge of the water or in the shade on the bank of the *igapo*, and taps the water with the tip of its tail, to simulate the noise of the falling Tambaquy fruit. The Tambaquy fish rush toward the sound and the agile beast scoops them out or dives in after them.

Dr. Paul Fejos, Director of Research of the Viking Fund Inc., New York City, learning of my search for data on the tail-fishing jaguar, has kindly written (personal communication) that:

> During my field trip to the Upper Amazon (1940–1942), one of my Yagua informants, Puricho, at the Rio Ampiyacu, told me that the jaguars along the rivers of the district eat fishes. When I questioned him as to how the jaguar obtained the fishes, he explained that 'It catches the fish by casting with its tail on the water and then by scooping them out with its paw.' Although I myself have never seen this occurrence, I must say that during my stay with the Yagua I found Puricho a reliable informant.

It should be noted that Doctor Fejos' ethnological work was done on one of the northwestern tributaries of the Amazon, in the same general region where Koch-Grünberg worked and heard the jaguar tail-fishing story.

Dr. George S. Myers, Curator of Fishes in the Museum of Zoology at Stanford University, has for 2½ years been working in the Museu Nacional at Rio de Janeiro. Appealed to for evidence from Brazilian observers, he has sent me certain data of much value. Just at this point he may be quoted as follows:

> Mr. Joao Moojen, the Museu's mammalogist, says that Mr. Passarelli, who used to be employed by the Museu as a field man, told him that in Matto Grosso the jaguars fish [ordinary grappling fashion] from the trunks of low trees overhanging the water. And that the Indians say that the oncas select fruit trees [from which to fish, since] under them the frugivorous fishes gather to eat the fallen fruit.

Neither Mr. Moojen nor Mr. Passarelli had heard any accounts of the jaguar's use of the tail as a lure. But it is significant that these accounts (that the jaguar selects for its ordinary hooking-out fishing the very same fruit trees that it is alleged to seek for its tail-tapping fishing) tie up with each other. The one fishing might have an easy transition into the other, as will be suggested later.

This concludes the widespread accounts quoted from Indians and "reputable whites" that the jaguar uses its tail as a lure for the fishes. Coming from different men and different regions throughout the Amazon Valley, they are worthy of consideration. And now may be invoked the old saying that there must be

some fire where there is so much smoke. The "smoke" began with Rengger in Paraguay in 1830, and eddied upward in the Amazon Valley with Wallace (1853), with Clough (*ca.* 1873), Smith (1879), and with Magalhaes (1931); and with Koch-Grünberg (1921) and Fejos (1940–1942) in the northwestern tributaries of the Amazon and Rio Negro—a stretch of 1800 air-line miles northwest-southeast, and east-west in the Amazon Valley several times that many miles following the curves of the great river and its tributaries. And now for the "fire."

William Lewis Herndon, a naval officer of ability and standing, was chosen in 1850 by the U. S. Government to descend the Amazon and to report on the possibility of the development of trade along the river by U. S. interests. The account of his leisurely descent of the river is found in his "Exploration of the Valley of the Amazon, Part I" (Washington, 1853). A reading of his book shows that he justified the confidence of his superiors. From our standpoint, it is interesting that this book on nearly every page abounds in sound natural history notes.

At Santarem he met a young French engineer-explorer, Alphonse Maugin de Lincourt, who had just returned from a trip to the cataracts of the Tapajos River. In over 10½ pages of his book, Herndon translates natural history and other notes apparently verbatim from de Lincourt's journal of the trip.

THE ENGINEER, DE LINCOURT, AN EYE WITNESS

Of particular value is de Lincourt's statement that, having arrived at the foot of the fifth cataract, his Indians were so exhausted that they could not keep watch, so he was sentinel since the banks of the river were infested with jaguars and other wild Felidae. Here is what he avers that he saw (Herndon, p. 312):

> Walking along the beach to prevent sleep, I witnessed a singular spectacle but (as I was informed by the inhabitants) one of frequent occurrence. An enormous tiger [jaguar] was extended full length upon a rock, level with the water, about 40 paces from me. From time to time he struck the water with his tail, and at the same moment he raised one of his fore-paws and seized a fish, often of enormous size. These last, deceived by the noise, and taking it for the fall of forest fruits (of which they are very fond) unsuspectingly approach, and fall into the claws of the traitor. . . . I did not interrupt him, and when he was satisfied he went off.

I cannot find that de Lincourt ever published the account of his travels on the Tapajos. At least it is not listed in the published catalogues of the Bibliotheque Nationale and of the British Museum. But an anonymous writer in a book, "The Amazon and its Wonders" (London, 1881), quotes (page 136) from Herndon the de Lincourt account of the jaguar, and he does more for he has an illustration purporting to show this fishing—which is reproduced herein. However, this figure shows the jaguar crouched not on a rock but on the base of a tree leaning out over the water. Furthermore, the jaguar's tail does not dip into the water as would be expected. Whether the unknown author of this little book failed to supervise and control his artist or whether he copied the illustration from some other book, cannot be said. But it should be noted that

this is the only illustration, that has come to light in this study, of a jaguar in the act of fishing; hence, it seems well to reproduce it.

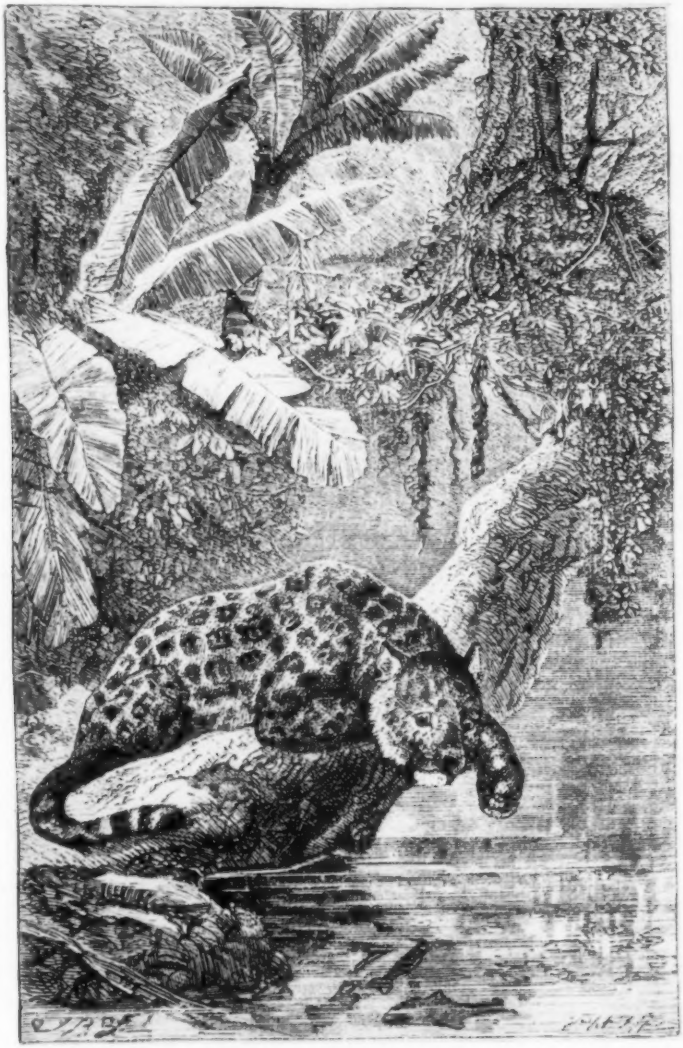

FIG. 1. A Jaguar, from the base of a tree leaning over the water, hooks out the fishes swimming below. From "The Amazon and its Wonders," 1881.

It should be emphasized that de Lincourt ascribes the assembling of the fishes to the fact that these attribute the noise of the tail-tapping to that made

by their favorite fruits falling into the water, or to the disturbance due to the grappling out of the fish by the jaguar. De Lincourt is the fifth man independently to offer this falling-fruit explanation of the origin of the tail-tapping.

And now, strange to say, there is in 1942 supporting evidence for the use of the tail in fishing by the jaguar.

USE OF THE TAIL AS A LURE IN FISHING BY A DOMESTIC CAT IN 1942

Mr. Carl Spencer of Spencer, N. C., operates a copyrighted service called "Odd Facts in Carolina" in the Sunday issues of a number of North Carolina papers. This consists of drawings and the accompanying captions after the fashion of Ripley's "Believe It or Not." In the Sunday editions of July 12,

FIG. 2. Drawing of a cat fishing with its tail in a goldfish pool. By courtesy of the artist, Carl Spencer, 1942.

1942, appeared the figure of a house cat fishing with its tail in a garden pool. Through Mr. Spencer's courtesy this illustration is reproduced herein from his original drawing.

Immediately after seeing the newspaper reproduction of this drawing, I wrote Mr. W. G. Heavner, a well known resident of Newton, N. C., whose fish pool was being devastated. He courteously replied as follows:

> I have in my backyard a circular cement pool about seven feet in diameter and 20 inches deep. At one point in the rim, a couple of stones were set in the wall about two inches above the water level. On this shelf I had planned to place a dummy frog. To this pool, with its constant supply of water, all the neighbors' cats and dogs would come to drink. Sometimes one of these cats would sit on the projection while drinking.

This pool was heavily stocked with goldfish, but presently these began to disappear. My five-year-old grandchild told me that she had seen a large gray tomcat, which belonged to a neighbor, catching the fish in my pool. It was hard for me to believe this until I caught him in the act. This cat apparently learned that the fish would come up when the water was disturbed. So he got to sitting on the rock projection with his tail in the water and would wiggle it to attract the fishes, and, when they would come up to see what was happening, he would snatch one out. He would not eat the fish on the spot but would first carry it home to my neighbor's.

Before my letter reached Mr. Heavner, an attempt had been made to kill the cat to prevent further raids on the goldfish. This was not successful, but it apparently so scared him that he never came back to the pool again. From the standpoint of animal behavior, this was most unfortunate, since it made impossible any further observations and, what is much worse, the taking of photographs showing the cat in action. Such a photograph would be priceless to establish visually this curious and most interesting feline behavior.

ARE THESE ACCOUNTS CREDIBLE

In endeavoring to answer this question, let us "sum up the evidence" from Rengger (1830) to Fejos (1942). Ranging over a time span of 112 years, the accounts are cumulative and impressive. Next let us consider some of the men who published this evidence and those from whom they got it. This will form some foundation for belief in the story.

Wallace, after four years on the Amazon and Negro, puts his account not in his "Narrative" but in his "Observations on the Zoology of the Amazon District." It is found in his account of the habits (and particularly the feeding habits) of the jaguar, which he got from his keen-eyed Indian friends. He, in the same year as Herndon (1853), published the falling-fruit explanation. To me it seems plain that Wallace gave the story at least some credence.

Smith says that (in his four years' study of the natural history of Amazonia) he heard the story everywhere and from persons who averred that they had seen the fishing. It would seem that he too gave some belief to the account.

Koch-Grünberg, a man of high scientific standing, had the story not merely from the Indians but from "reputable whites" and showed his attitude of mind by saying "It is not altogether impossible."

And lastly, Doctor Fejos, another trained scientist, quotes the story from one of his men whom he had always found thoroughly reliable. He, too, seems to think that there is something in these widespread stories.

Corroboratory are the statements of Rengger (1830), Clough (*c.* 1873), and Magalhaes (1931).

Finally, there is the engineer, de Lincourt, who claimed to have been an eye witness. Herndon was closely associated with him for a month and gave his story full credence.

None of these men (quoted above) knew or was ever associated with any other (except Herndon and de Lincourt). And not one in his book refers to what any of the others had written. Yet each man wrote the same short, simple account in almost identical words. Now let us consider the sources from which their accounts came.

It is incredible that there could have been any collusion among the Indians or among the whites living in the primitive and isolated Amazonian communities of the latter half of the 1800's, when communication was very difficult and very limited. More incredible is it when one considers that the tale is told from Paraguay (1830) to the headwaters of the Uapes and the Ampiyacu (1921 and 1942) and throughout the length and breadth of Amazonia—an area of about 2,500,000 square miles.

Is it not more credible that these peoples, Indians and whites, separated from other communities (where the story is told) by hundreds and thousands of miles of Amazonian jungle, tell the same story of the jaguar and give the same explanation because it describes what they had seen? This story must have originated separately in each community and have been based on personal observations or upon knowledge common to the community. It is notable that all the accounts agree in the simple bare essentials.

From these arguments concerning the credibility of the accounts quoted, let us turn to the one alleged eye-witness account by a man of scientific training, that of the engineer, de Lincourt. This takes us back to 1853 (the date of Wallace's book). Herndon's translated quotation from de Lincourt's diary states that de Lincourt actually saw the tail used as a lure. Herndon, an experienced naval officer, was not a man to be taken in by "tall tales," and it is clear that he gave full faith to this account of the jaguar fishing with its tail.

In the face of all these allegations and explanations of the particular behavior of cats wild and domestic set out above, some of my readers are still asking: "What belief can be given to a matter so extraordinary?" This calls for a brief study of cats, their intelligence, their behavior, and particularly of their use of the tail; and, since domestic cats are the better known, their tail behavior will be taken up first.

CATS ARE INTELLIGENT ANIMALS

That this is true, the animal behaviorists have shown with their trapdoors, mazes, and other experimental paraphernalia. Their cats learn by experience. The books about cats abound in incidents which show a high grade of keenness. Being highly organized, intelligent, and inquisitive, cats are attracted by things in motion and by sounds. The cat responds quickly to moving things and to sounds inaudible to us. Thus a cat at a mousehole can undoubtedly hear the mouse before it appears. And the twitching tail tells the story of her pleasurable anticipation. The tail is the cat's most emotional member.

Cats love to tease other cats and also dogs. I have read an eye-witness account of a cat which was stretched out on top of a fence alongside an open lot. A small dog saw the cat, charged across the lot barking loudly, and leaped up on the fence but short of the cat. The cat, perceiving that it was out of reach, enticed the dog by dropping its tail over the fence and keeping it in motion just out of reach of the canine's jaws. This was kept up until the dog, worn out by his barking and leaping, slunk away. Here the tail was plainly used as a lure.

Now let us study Mr. Heavner's cat which used its tail as a lure for the fish. This is a most extraordinary bit of behavior by a domestic cat, and there are certain things that need to be considered in endeavoring to explain it. Goldfish are generally quite tame, are accustomed to being fed at the surface of their pool, and are attracted by anything serving to disturb that surface ever so lightly. Not only will they come up for bits of food, but for scraps of paper or any small debris, or to the tickling of the surface of the water by a twig. So much for these fish.

The cat comes to the little platform to drink. The lapping attracts the fish, but they see the cat and stay some distance away. The cat perceives this much-loved prey just out of reach and in eagerness and hunger twitches its tail and this touches the water. The fish come up to investigate and one falls a victim to a swift stroke of the cat's paw. Finding it easy thus to obtain its favorite food, how long would it take this observant and intelligent animal to form such a fishing habit?

But let us turn from the food-getting of this one cat, to that of cats in general. The house cat is fed by his mistress, but the masterless cat must depend on his wits to find his food where he can—mainly in man's garbage pails and in the occasional bird or rat also attracted by the garbage. In these food-findings he becomes expert. His food sources are definite and limited but not easy, and he must use his wits. On the other hand, the wild jaguar must seek his food in the lowlands, in the woods and rivers. His prey is free to move, is afraid of him and must be captured by stealth and by superior strength. He must outwit it or go hungry. One of his most available foods is found in the fishes which swarm in the Amazonian waters. And when his "fish appetite" takes him to the turbid waters, he must here use his best deception—his tail-tapping.

HOW THE JAGUAR MAY HAVE LEARNED TO USE HIS TAIL AS A LURE

It has long been known that in South America the jaguar does not hesitate to swim rivers and that fishes, caught by a stroke of his paw, constitute an ordinary and much-loved prey. But ordinarily he must wait for the fishes to come within reach so that he can grapple them out. This being so, is it not reasonable to believe that this intelligent animal might sooner or later develop some method of enticing the wary fishes within reach?

That the jaguar uses its tail in fishing has been alleged for over 100 years. Taking for granted that these cumulative allegations may be true, as argued above, let us ask how this habit might have come about.

Those who have studied and hunted the jaguar describe him as stealthy and cunning, given to strategy to effect the seizure of his prey. Further, it is stated that he constantly twitches his tail as he watches and creeps up on his unsuspecting victim. As to his manner of fishing, the steps seem not unclear. Attracted by fishes playing at the surface of the water, he hangs over logs or rocks projecting over streams under the trees whose fruits are sought by certain fishes and hooks them out as they swim past. When fruits from the overhanging trees fall into the water, then fruit-eating fishes hungry for these swarm

to the surface for them only to fall prey to the hungry fisherman. But if the fruits do not fall, might not the jaguar in hunger and anger thresh his tail about, sometimes striking the water? The fish, hearing the sound and mistaking it for that made by the falling fruit, come to the surface and are scooped out by the jaguar. A few experiences of this kind might be sufficient to start a habit in this animal.

Leading to belief in the accounts that the tail-tapping of the jaguar attracts certain Characin fishes are Smith's statements describing how other Characins flock to the surface when the water is disturbed. In his book he says (p. 99) that: "Our northern troutfishers . . . [would be] scandalized to see these [Indian] boys thrashing the water with their poles to *attract* [italics his] the piranhas."

Again he states (pp. 284 and 332) that, at two other localities, far distant from each other and from the first, the Indians would beat on the water to attract the piranhas. And though none had been visible, they would come at once in numbers. This practice is evidently common throughout much, if not all, of the Amazon Valley.

The reader now has the evidence that two kinds of Characins (one carnivorous, the other frugivorous) swarm to the surface when the water is disturbed. Does it strain his credulity too much to believe that the jaguar has (as described above) learned to use his tail in like manner to attract his prey?

Just here the question may well be asked, "Do other fish-eating animals in any comparable fashion lure fishes to their destruction?" The answer is that interestingly enough there are some that do.

OTHER ANIMALS THAT LURE FISHES

Accounts will now be given of two fish and two birds whose somewhat similar activities in luring their prey lend some credence to the alleged use of his tail as a lure by the jaguar.

Lophius and his lure.—*Lophius* is a flat and flabby fish, mostly all head and with a cavernous mouth, whence the designation "all-mouth." His dorsal spines have been moved forward to the top of the head, have become elongate, and droop forward. The tip of the anterior one is expanded into a fleshy mass. Since the days of Aristotle (384–322 B.C.) this angler has been credited with dangling the large anterior tentacle in front of its closed mouth to lure fishes close thereto; and, within the past few years, this fishing has been seen and described by several scientific observers. When one or more fish come up to nibble at the lure, the great mouth opens spasmodically, the fishes disappear therein, the mouth closes, and the lure is in place for the next catch. Because of this fishing method, *Lophius* has well been named "angler." This habit is practiced by others of its near relatives, the sargassum and other fishes.

If an animal, as low in the vertebrate scale as the angler, has evolved the use of the head tentacle as a lure for fishing, may not the jaguar, an animal near the top of the vertebrate tree, having much more intelligence and accustomed to using stratagem, have evolved the use of the tail as a lure?

Birds that lure fishes.—There have come to my attention in this study ac-

counts to two kinds of birds that lure fishes to their doom. One with more knowledge of the fishing habits of birds might suggest others.

The Brazilian Kingfisher will be considered first, since it comes from the same habitat as the jaguar. Doctor Myers writes that "Mr. Moojen [of the Museu Nacional in Rio] points out that kingfishers [either when flying or sitting on their perches over the water] defecate into the streams and then swoop down to catch the fishes thus attracted," and he adds that "The jaguar is a much more intelligent animal than a kingfisher."

Confirmation of the habit of fishes of rising to the surface to investigate the disturbance made by droppings from birds is a note from Dr. Robert Cushman Murphy. In the lower reaches of the River Buenaventura in Colombia, he has noticed catfishes rising to the surface when the boobies flying along would defecate into the water.

The black skimmer is a marine fish-eating bird which catches its fishes in a far more original way. It gets its name because it flies along very close to the surface of the water with the projecting lower mandible plowing up the surface of the water and at the same time small fishes which are caught between the two halves of the bill. Doctor Murphy has long studied this bird as it seeks its food and has come to certain definite conclusions about its feeding habits (Oceanic Birds of South America, 1936, vol. 2, pp. 1176–1177). He quotes the clearcut statements of various recent observers who have seen the skimmer pick up fishes from the surface, and for himself writes as follows:

> With these several items of testimony my own observations agree and, while watching the birds turn and cut the water again and again in the same small area during feeding evolutions, I have come to the conclusion that the only practical function of the flattened cut-water is to serve as a lure. Small fishes are doubtless attracted toward the surface either by the sight of the black and red beak moving rapidly along or, more probably, by the tiny surface circulation which it produces. The skimmer thus baits its own trail and, upon wheeling and returning, it takes advantage of the duped victims which have risen to investigate.

Then, to see if this slight disturbance of the water would attract the fishes, he states that, in the undisturbed murky river and lagoon waters of both Ecuador and the southeast United States, he has lightly cut the surface with a long switch. In many cases this was followed by the rising to the surface of small fishes, as if they were seeking the cause of the disturbance. From these observations he draws this conclusion: "The fact that feeding skimmers so frequently replow their own furrow tends to make such an explanation of their behavior convincing."

I submit that these observations on and conclusions from the actions of the angler, the kingfisher, and the skimmer strengthen the argument for the falling fruits and for the jaguar's tapping tail.

But there are still among my readers some who say, "How can we be expected to believe such an extraordinary thing as this using the tail for a lure, when it has not been seen and described by any scientifically trained man nor attested by a photograph from any source?" Passing by the statements made by both

de Lincourt (in 1853) and Heavner (in 1942) that they saw this fishing with the tail, let it be said that the evidences asked for are, of course, *the* incontestible proofs which the present writer, more than anyone else, earnestly desires. But the lack of them must not be allowed to controvert wholly the allegations of the men quoted, and the arguments presented which are based on these allegations and on the habits of other animals and of fishes. In the course of years of study of animals and their behavior, and thanks to extensive bibliographic work, I have learned that animals do so many extraordinary and unexpected things, that I am not ready to cast overboard as without foundation some alleged behavior (not physically impossible)—even such as the use of the tail as a lure by the jaguar.

In 1904, in the Biology Journal Club at the Johns Hopkins University, I reported on articles in the Bulletin of the Zoological Society of France (1903 and 1904) dealing with the appearance and behavior of a number of huge animals seen in the seas of Tonkin, French Indo-China, and thought to be specimens of the great sea serpent. When I had finished the report, the silence that followed was deep and painful. Finally one man plucked up courage to ask Prof. W. K. Brooks what he thought of this. He answered about as follows: "It is not safe to say that an animal does not exist, or that a known animal does not do certain things (not physically impossible), because no scientific man has as yet seen and described them."

In illustration of Professor Brooks' first statement, a number of long unknown large animals might be cited (*e.g.*, the okapi and the whale shark). The latter is the largest fish, rivaling the whale in size. With its huge foreparts and its flat square-cut head densely covered with white spots, and with its sides marked in squares with a large white spot in each, it is the most vividly-marked surface-living shark. Yet up to 1912, it was almost unknown. Today it is perhaps the best known of the large sharks.

Illustrative of Professor Brooks' second point—the matter of unusual behavior by animals—the extraordinary things that animals do can be cited by scores of students of animal behavior. I have brought many such accounts together in a series of articles citing animals from hydras to cats and dogs as predators on or enemies of fishes. Then when one comes to study the habits of fishes—animals at the very bottom of the vertebrate tree—the extraordinary things that they do would fill a book. There are a dozen kinds of fishes that make and guard nests. There are scores of species in which one parent or the other incubates the eggs in the mouth. Another carries the eggs gathered together in a grape-like bunch attached to a hook on its forehead. Along other lines of behavior, it is recorded that some fishes swim heads and tails, tandem-fashion; others play leapfrog (of two kinds); still others line up in evenly spaced ranks like soldiers. All these behaviors are attested by many scientific observers, and for the last I have photographs. Behavior in other animals is fully as unusual and extraordinary.

In all my studies of the habits of animals, I have constantly borne in mind Professor Brooks' admonition. Just here I think that it is entirely applicable.

And now a final word as to the alleged method of fishing under consideration. The tail-tapping fishing by the jaguar is not a physical impossibility—as Koch-Grünberg pointed out in 1921. Further it would seem, in view of the lashing of the tail by cats in anger or in anticipation, that using the tail as a lure may not be improbable. In short, I am willing to let the verdict stand as "entirely probable" while waiting for some scientifically trained man to see this fishing, and for someone to record it with a camera. But in the meanwhile, let there be recalled the saying of one prominent student of the jaguar: "Anything but the impossible may be expected of a wild animal."

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MAMMALS FROM WELAKA, PUTNAM COUNTY, FLORIDA

By Joseph C. Moore

Since attention was called to the desirability of lists of mammals from neglected areas within the state of Florida (Sherman, 1936, p. 102), two such papers have appeared: Hamilton (1940) and Rand and Host (1942). To these it is desired to add the present paper. The information presented was acquired as a result of field work on the University of Florida Conservation Reserve at Welaka, Putnam County, Florida, in connection with graduate studies.

The writer is indebted most to H. B. Sherman, who as the writer's committee chairman, did everything in his power to help and promote this work. J. Speed Rogers' help in making financial and other arrangements is gratefully acknowledged, and the writer is indebted to the University of Florida for the excellent facilities at the Reserve and for a graduate scholarship held during one four-month period. Particularly helpful with information and records were fellow students doing field work at the Reserve: namely, Albert M. Laessle, James J. Friauf, O. Earle Frye, and E. Lowe Pierce. The superintendent of the Reserve, William M. Dunson, and his wife, as well as the staff forester, Charles Root, and the fire tower keeper, Victor Rich, were generous with help and information. Residents of Welaka, particularly Henry Waller and Ed Palmer, furnished information about some of the larger mammals. William H. Stickel of the Division of Wildlife Research of the U. S. Fish and Wildlife Service kindly identified the remains in a series of great horned owl pellets collected under a nest on the Reserve.

The University of Florida Conservation Reserve lies adjacent to Welaka on the east side of the St. Johns River opposite the wilderness of the Ocala National Forest and within sight of where the Oklawaha River empties into the St. Johns. Its 2,180 acres are spread along 4½ miles of St. Johns River shore line and extend inland about 1½ miles. It is game-fenced in two divisions. These are separated by the paved road which passes through the length of the Reserve. However, the division on the river side is left unfenced for 3,500 feet at the north end, and at the shore line the river itself is the only barrier.

Laessle (1942) has described in detail the vegetational associations and communities of the Reserve. For the purpose of discussing the local distribution of mammals these are lumped to form the nine generalized vegetational associations shown on the accompanying map. These are as follows:

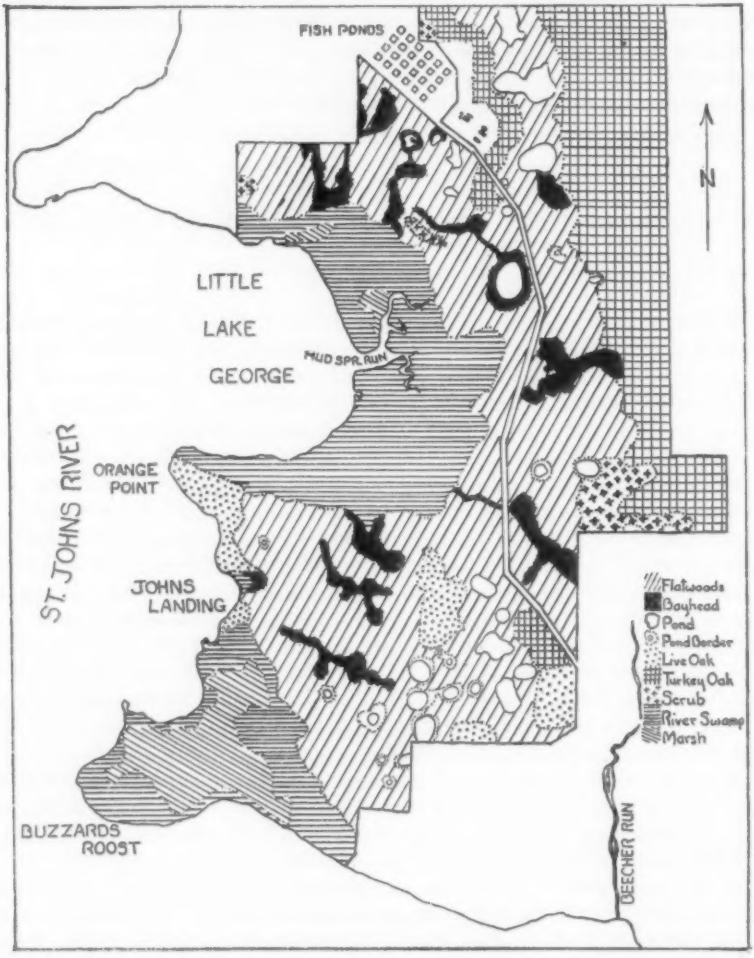

FIG. 1. Vegetation types on University of Florida Conservation Reserve at Welaka.

1. The *flatwoods* is all nearly level, sandy land with thinly scattered, tall pines standing solitary above a low growth of shrubs and herbs, among which gallberry, palmetto, fetterbush and wiregrass are prominent.

2. The *bayheads* are stands of hydrophytic trees dominated by broad-leaved

evergreens, which occur in depressions in the flatwoods that are seasonally flooded.

3. The natural *ponds* are frequently shallow and many are invaded by moss and ferns, grasses, or bays and other hydrophytic trees.

4. The ponds are in many cases bordered by a narrow band of shrubs, called a *pond border*, which differ sharply from the surrounding vegetation of the flatwoods.

5. One of the several *live oak hammocks*, a beautiful park-like woods of some 25 acres, lies like an island in the flatwoods toward the south end of the Reserve. Gopher tortoise burrows, brush piles, and Spanish moss in this hammock provide adequate refuge for many small mammals, and the great crop of acorn and pine seed mast attracts in season many mammals that do not live there the year round. Conditions in the life oak hammocks at Johns Landing and Orange Point are similar.

6. An association called high-pine turkey-oak, or for convenience just *turkey oak*, covers the sand hills on the eastern side of the Reserve. It is very dry, and undergrowth is generally sparse or lacking. Neither the scrubby seedling oaks and wiregrass nor dead leaves cover all the white sand, which shines through looking like snow when seen from a short distance. Gopher tortoise burrows and pocket gopher mounds are prominent in this area.

7. The *scrub* occupies rather small, scattered areas that rise a foot or more above the general level of the surrounding flatwoods. It is characterized by several species of scrubby oaks and the predominantly evergreen and scrubby nature of its vegetation.

8. The *river swamp* is a dense, jungle-like growth of large maple, ash, elm, water tupelo, cabbage palmetto, and a little cypress. Water covers much of the ground during a large part of the year, and a nearly impenetrable growth of saw palmetto, etc., forms a formidable understory in the portion that rises toward the higher ground of the flatwoods.

9. *Marsh* occurs in some places within the swamp area, spartina grass and sawgrass being dominant over extensive areas. The marsh at Buzzards Roost covers perhaps a hundred acres. This is the only one of the nine associations in which no trapping was done.

Certain man-made and natural features are worthy of mention. Fourteen truck trails form a network, giving easy access to a large portion of the Reserve, and another network is formed by the ploughed firelanes. A hundred-foot fire tower stands approximately in the center of the Reserve. Mud Spring Run flows from a large spring of sulphurous, sparklingly clear water. Just off either end of the Reserve lie numbers of U. S. Fish and Wildlife Service ponds and establishments, one set of which is shown on the accompanying map. The truck trails and firelanes affect mammal life at least to the extent of providing acceptable runways for foxes, raccoons, oppossums and deer. Frye (1941, p. 15) found that the trail sides and trail-side ditches on the Reserve provided more plant food for quail than did the open flatwoods. This may also be true for some of the mammals.

Twenty-one days were spent afield in the spring of 1940 in periods of two or three days scattered from February through May. The following fall the writer and his wife lived on the Reserve from mid-September to mid-January of 1941, and again in the spring of 1942 from February to May, inclusive. Trapping, recording the observations of others, hunting by day, hunting with a headlamp by night, and watching from tree platforms contributed in about the order stated to the information gathered into this paper.

Small Sherman live traps, somewhat larger pocket gopher traps (Sherman, 1941), and large box traps with a conventional drop door were the live traps employed. Number "0" jump traps were excellent for round-tailed muskrat and about as useful for opossum and small raccoons as the number 2 double spring type. Number three double spring steel traps shattered the leg bones of a rabbit and an opossum, and use of them was discontinued. Moles were taken in the "Out-o-sight" mole trap figured in Silver and Moore (1933, p. 11).

TABLE 1.—*Comparative abundance of small mammals*

ASSOCIATION	RIVER SWAMP	LIVE OAK	BAYHEAD	FLATWOODS	SCRUB	POND BORDER	TURKEY OAK	TOTALS
TRAPNIGHTS	264	172	733	2795	192	653	331	5140
Bachman shrew	0	0	1	0	0	0	0	1
Florida short-tailed shrew	0	0	0	2	0	1	0	3
Carolina short-tailed shrew	0	0	4	1	0	1	0	6
Cotton mouse	17	2	9	62	0	7	4	101
Golden mouse	0	0	3	0	0	0	0	3
Gopher mouse	0	0	0	1	5	0	0	6
Rice rat	0	0	1	0	0	1	0	2
Cotton rat	4	0	3	28	0	15	0	50

Some information was obtained on *Mephitis*, *Sciurus*, *Glaucomys*, *Sigmodon*, and *Sylvilagus* from great horned owl pellets collected under the nest at intervals during the 15 days before the two young left it on March 25, 1942.

Table 1 suggests the local distribution and comparative abundance of small terrestrial mammals taken in live traps. It should be noted that: 1. Golden mice were in four cases observed in turkey oak or scrubby transition zones between turkey oak and flatwoods ponds, whereas the table gives the impression that they occur most abundantly in the bayhead. 2. The one gopher mouse recorded from flatwoods was taken in scrubby flatwoods a quarter of a mile from the patch of real scrub where the other five were taken. It seems likely that this one had wandered from the scrub, for several hundred trap-nights in that and adjacent flatwoods areas caught cotton mice but failed to take another gopher mouse. 3. The portion of river swamp in which the four cotton rats were taken was in a stage of transition from marsh to swamp and still retained some sawgrass. Cotton rats were not taken in the more densely forested swamp.

In the following discussions measurements of specimens are recorded in the

usual order of total length, tail length, length of hind foot including claws, ear length from crown, and weight. Length is measured in millimeters and weight in grams.

ACCOUNTS OF SPECIES

Didelphis virginiana pigra Bangs, Florida Opossum.—Specimens were taken in bayhead, river swamp, live oak hammock, and flatwoods. Tracks indicate that opossums range throughout the Reserve, possibly excepting the higher parts of the turkey oak.

On March 15, 1942, a dead opossum was found beside the road in the flatwoods near a bayhead, presumably a highway casualty. It was cold and stiff, but of the two young protruding from the marsupium and being attacked by ants, one was still alive. Inside the pouch were four more dead and one more living. The two live ones were fed cow's milk with an attenuated pipette, but after one had died within eight hours, the effort was abandoned. Six of the seven young were females. One of them measured 62–16–5–2 and weighed 33 grams. The others did not vary from that more than two millimeters in tail length and two grams in weight, excepting the two that had been found alive. They were down in weight to 29 and 25 grams. The mother measured 702–304–60–48. Another female taken November 6, 1940, in a box trap measured 673–310–60–48. A male taken in a steel trap later in the same month measured 787–354–68–50.

Scalopus aquaticus australis (Chapman) Florida Mole.—Surface tunnels of moles were abundant in the flatwoods and the live oak hammocks. Tunnels were also noted in the turkey oak and river swamp. Twenty-three trap-nights with mole traps set on surface tunnels yielded two moles, one from the Orange Point live oak hammock, and one from the lawn. Victor Rich plowed up a live male mole in a flatwoods firelane and captured it for the writer. In the scrub beside a firelane a female, containing two young, each weighing two grams, was found dead on May 8, 1942. The mother, whose weight may have been affected by the desiccation evident in her extremities, measured 128–20–16 and weighed 35.3 grams. The skull and many ribs were broken, but no injuries showed externally. The specimen taken in the live oak hammock October 12, 1940, was found to have an orange-yellow patch of fur on the abdomen in front of the right hind leg. Jackson (1915, p. 17) points out that such color patches are fairly common among moles of this genus.

Two males measured 141–22–17 and 142–24–18 and weighed 47.3 and 28.2, respectively, the weight of the latter being low due to starvation. A sexually inactive female taken February 2, 1940, measured 136–22–18 and weighed 43.6.

Sorex longirostris longirostris Bachman, Bachman Shrew.—One specimen of this long-tailed shrew was taken, as already recorded by the writer (1943, p. 404), on a trapline chopped through the dense tangle of a large bayhead.

Cryptotis parva floridana (Merriam), Florida Short-Tailed Shrew.—Six specimens were acquired, five of them in the flatwoods and one in a flatwoods-pond border. Friauf took two of these in "molasses traps" set for orthopterans, one was found dead by the roadside, and the other three were taken in small live traps. One was kept alive for three and a half months. As shown by the writer (1943, p. 156), this shrew appears to have a greater range of habitat tolerance in this area than *Blarina* and seems to prefer drier situations.

Blarina brevicauda carolinensis (Bachman), Carolina Short-Tailed Shrew.—Six specimens were taken, all in moist situations: one in a flatwoods-pond border, four in bayheads, and one in the open flatwoods. A female taken October 18, 1940, contained four very young embryos. She measured 93–20–11 and weighed 7.1. Compared with others weighed by me and with the weights of nine given by Rand and Host (1942, p. 4), this shrew was unusually light. Measurements of other specimens are:

92–22–13, wt. 11.5..... male taken February 28, 1940
97–22–13, wt. 10.5..... female taken April 20, 1940
92–21–12, wt. 8.8..... female taken April 20, 1940
92–20–11..... (sex?) taken April 8, 1942

Lasiurus seminola (Rhoads), Seminole Bat.—Many efforts to obtain specimens of bats were made between sundown and darkness out on the wide lawn surrounding the laboratory, the truck trails, and the wide surface of Mud Spring Run. Very few bats were seen. One male of this species was shot down over the lawn on December 10, 1940. It measured 102–45–8–8 and weighed 9.3.

Tadarida cynocephala (LeConte), LeConte Free-Tailed Bat.—A female of this species was brought to me by Mrs. Dunson whose gardener had captured it in her garage on March 3, 1942. It measured 101–35–9–14 and weighed 10.0.

Euarctos americanus floridanus (Merriam), Florida Black Bear.—Charles Root believes that a bear passes through the Reserve every year, although he has not always found sign. Henry Waller says that bears pass through the Welaka area occasionally and that they are more numerous than panthers and have a smaller range. He believed in 1940 that the number of bears had increased in the previous few years.

Procyon lotor elucus Bangs, Florida Raccoon.—Tracks indicate that the raccoon prowls the entire Reserve. Five were taken at various times in steel traps, and two young ones about one-third grown were captured by hand on October 7, 1940. These animals seem to be comparatively numerous. Henry Waller said that the drop in value of pelts from $5 to $1.25 had ruined trapping as a livelihood, and as a consequence raccoons had been allowed to increase so that in three nights of collecting along the river banks with a light and a rifle, 21 were taken. Waller tells me of three "kinds" of raccoons in this area: gray ones, black ones, and red ones. Five or six distinctly black ones have been taken on Drayton Island up the river, he asserts. The "red" ones seem to be ordinary gray excepting for a reddish tinge.

On three occasions on the Reserve raccoons were seen rambling in the bright daylight at 10 or 11 o'clock in the morning, once by Frye and twice by the writer and his wife. Friauf often shined their eyes at night with a headlamp. An adult male specimen weighed 14 pounds and measured 860–300–134–50.

Mustela frenata peninsulae (Rhoads), Florida Weasel.—As shown elsewhere (1945, p. 248), L. A. Morris of Welaka tells me of a weasel that the late Jim Fowler of Welaka trapped near Mud Spring Run about 1925.

Lutra canadensis vaga (Bangs), Florida Otter.—Otters have not been detected anywhere except along the water courses and ponds, but it seems probable that they cross areas of flatwoods and follow bayheads to reach some of the ponds and places where they have been observed. No specimen was taken on the Reserve, but a photograph is extant of Mr. Frye holding up by the tail a half-grown otter that he had run down afoot in the area of shallow artificial fish ponds at the north end of the Reserve, capturing it by pinning it down with a stick and picking it up by the tail. For a week or so in mid-July 1939 this young otter was observed in the fish pond area evidently feeding upon crayfish, frogs, insects, etc., for at the time there were no fish in the ponds.

Root observed a family of otters, the old pair and two cubs, one summer about 1937 on Beecher Run just south of the Reserve. He recalls that they fished about 10 a.m. and between 2:30 and 4:00 p.m. When one caught a fish, it came to the surface and shook it in the air. After eating, they frequently sprawled out on the bank "like boys taking a sunbath." Rich saw an adult and two young cross the main road of the Reserve in mid-summer of 1938.

Henry Waller believes that otters increased 40 per cent in numbers between 1939 and 1942 because the trappers were driven to other pursuits by the decrease in fur prices from about $25 to about $8 for a pelt. On the Oklawaha River about 15 miles from the Reserve, while drifting downstream in a skiff in January 1941, the writer and his wife saw otter four different times in one day.

Mephitis mephitis elongata (Bangs), Florida Skunk.—Skunks were observed by someone in nearly all parts of the Reserve. Their sign was frequently encountered along the truck trails through the flatwoods, and their musk often hung in the night air giving ample evidence of their presence to the observer. Friauf, Frye, all of the Reserve staff, and Mrs. Dunson have all seen skunks in one or more places on the Reserve and described them to me as *Mephi-*

tis. I have seen several dead *Mephitis* on the highways within 15 miles of the Reserve. Palmer, who is familiar with "civet cats" (*Spilogale*) from trapping around New Smyrna, is quite certain that the latter do not occur in the Welaka area.

"Chuck" Root saw an adult and three little skunks in the flatwoods near the laboratory about 7 a.m. of May 13, 1942. Frye observed a skunk in the live oak hammock and crept near to watch it dig up terrapin eggs one by one, carefully opening each and eating it with the utmost nicety, licking each shell clean.

Of the 30-odd pellets picked up under the nest of a great horned owl on the Reserve, one was 90 per cent remains of *Mephitis*.

Urocyon cinereoargenteus floridanus Rhoads, Florida Gray Fox.—One specimen, a female in excellent condition, was taken in a steel trap in the turkey oak November 17, 1940. Its stomach contained a mass of insect parts. It measured 933–348–133–73.

Foxes were observed by all of the Reserve staff, Frye, and Friauf, sometimes by day and sometimes at night. Their tracks were observed on the Reserve on all of the trails and firelanes, giving some indications of regularly traveled routes through scrub, live oak hammock, turkey oak, and flatwoods.

Felis concolor coryi Bangs, Florida Panther.—During October 1940, Root and Rich both reported panther tracks on the Reserve. Root says that a panther passes through nearly every year, spending about 10 or 15 days in the area and living on the wild pigs and deer. Palmer concurs with the opinion that a panther ranges through the Welaka area somewhat regularly, and adds that the panther seems to have an immense range, much larger than that of the bear. In August 1941, during a welter of panther reports about Welaka, William McLane, then doing research at the Reserve, recorded and sent me a series of the reports. H. C. Cooper was reported to have seen the panther. Four of the best dogs of a pack had been killed and "brutally mutilated" when the panther had been temporarily cornered. Arthur Chestnut had tracked the big cat a considerable distance and lost the trail. Several other people were supposed to have seen it and shot at it.

Lynx rufus floridanus (Rafinesque), Florida Bobcat.—Tracks of the bobcat, which were encountered more frequently in swamp, flatwoods, and live oak hammocks than in turkey oak, were seen less frequently than those of fox, raccoon, or opossum. About 1937 Root and Rich took a male and a female within 10 days in the same steel trap set in the flatwoods near the river swamp. About this same time on the Mount Royal estate, which borders the Reserve on the south, wildcats were so destructive to turkeys that intensive trapping was inaugurated and, according to Duff McLeod of Welaka, about 10 wildcats were taken. Rich observed a wildcat catch a rabbit below the firetower in the flatwoods close to the swamp. This was in daylight, and also in daylight Moss of Welaka saw a large wildcat start across the main road of the Reserve in November 1940.

Sciurus carolinensis carolinensis Gmelin, Southern Gray Squirrel.—Gray squirrels occur abundantly on the Reserve, but are largely confined to the three larger live oak hammocks, the river swamp, and some of the bayheads. One was seen in the edge of the turkey oak, but it fled into a large adjacent bayhead. Harper (1927, p. 325) found substantially the same habitat preferences indicated by this squirrel in the Okefinokee Swamp.

Several nests were examined in the Orange Point live oak hammock in February 1942. They were composed largely of Spanish moss, but also included oak twigs with the dried leaves adhering. These empty nests were rather shapeless, simple bundles about 15 inches in diameter, set in crotches of small branches about 20 feet from the ground in 30-foot trees which formed a dense, uniform stand. Other nests have been seen much higher in large live oaks.

Half-grown squirrels were seen in October 1940. Three that seemed young were observed eating samaras in a red maple in the swamp on March 9, 1942. A very young squirrel was seen in the possession of one of the boys of Welaka on March 25, 1942. Copulating pairs of this species were seen in August by Friauf, and late in January by the writer.

An individual with a distinct molt line on its hindquarters was seen February 23, 1942. Henry Waller says that a pure white gray squirrel was killed in Welaka about 1934 or 35.

The largest male and female of five specimens measured, respectively, 406–175–57–19 and 379–128–58–21 and weighed 413.3 and 406.7.

Gray squirrel remains constituted 90 per cent of one of the pellets picked up under the nest of the great horned owls.

Sciurus niger niger Linnaeus, Southern Fox Squirrel.—This species inhabits flatwoods, turkey oak, and bayheads. Although observed once in the edge of live oak hammock and once in the edge of river swamp, it seems definitely to prefer the open flatwoods and the turkey oak, nesting in the tall pines of these associations and of the bayheads. Harper (1927, p. 329) found similar preferences in the Okefinokee Swamp area: Maynard (1883, p. 23) reported their activities in Florida as restricted to the flatwoods; and Howell (1919, p. 36) states that in the southeastern states they "dwell almost exclusively in the open pine forests." Several were observed cutting on ripe pine cones apparently for the seed, and trimmed cones were often found in likely haunts of fox squirrels.

Remains of a juvenile *Sciurus* were reported in one of the pellets found beneath the nest of a great horned owl. These remains may be of this species, for fox squirrels were rearing young in the immediate vicinity of the owl nest. The nearest known haunt of the gray squirrel was more than ¼ mile away, but as shown above the gray squirrel was preyed upon by this owl.

Two adult specimens, male and female respectively, measured: 587–274–85–22 and 610–310–80–18.

Glaucomys volans querceti (Bangs), Florida Flying Squirrel.—Flying squirrels are numerous and comparatively easy to collect at night with a headlamp and .22 scatter shot. Although they usually confined their activities to live oak hammocks and turkey oak, individuals have been seen more than a hundred yards out in flatwoods, others heard and seen in swamp, and still others detected by scats left in abandoned fox squirrel nests in bayheads. Judging by the numbers heard squeaking and seen by headlamp at night, the densest populations occurred in the live oak hammocks and the next densest in the parts of the turkey oak where the oak trees are large.

In turkey oak where Spanish moss is not abundant, flying squirrels nest largely in woodpecker holes. In live oak hammocks it is believed that they nest nearly exclusively in outside nests in the Spanish moss. Sixteen outside nests which had evidently been constructed by flying squirrels were examined, nine of them having flying squirrel inmates when discovered. These nests were globular or near-globular with the small entrance high on one side. Frequently tney were constructed entirely of Spanish moss, although many had twigs with the leaves still attached. All outside nests and some of the 24 woodpecker holes from which flying squirrels were frightened or taken, were lined with the resilient black fibers of cured Spanish moss. Some of the woodpecker holes which were in use as flying squirrel nests had no lining or nesting material other than the small amount of chips left by the woodpecker. The outside nests were never more than 8 inches in diameter and averaged about 6 inches. Contrary to Sollberger's experience (1940, p. 292) with the eastern flying squirrel in Pennsylvania, scats were commonly found in the outside nests here, sometimes in considerable quantity.

Among the 30-odd pellets found under the great horned owl's nest, flying squirrel remains occurred in only two, constituting only 5 and 10 per cent of the remains. Considering that I was able to rout some 12 or 15 flying squirrels from nests within a radius of 300 feet of the owl nest, it appears that the big owl was having little success as a hunter of flying squirrels at the time.

Measurements of the only adult male and the largest female of five are: 212–101–30–14 and 225–104–31–13. These weighed 44.0 and 82.0 grams, respectively.

Geomys tuza floridanus (Audubon and Bachman), Florida Pocket Gopher.—Pocket gophers occur throughout turkey oak, scrub, and in several places in flatwoods. Their location is betrayed easily by the mounds of sand shoved up from their burrows, but the animals are seldom seen. A half dozen were taken by means of pocket gopher live traps. The largest male and female measured, respectively: 277–91–35–3 and 240–80–30–2. They weighed 246 and 147.4 grams.

Reithrodontomys humulis humulis (Audubon and Bachman), Eastern Harvest Mouse.—One specimen is known to have been taken on the Reserve (Hooper, 1943, p. 16). It is a male measuring 109–56–13–11. (The ear measurement is from notch in this case.)

Peromyscus gossypinus gossypinus (LeConte), Cotton Mouse.—This is the most abundant mammal on the Reserve. It was taken in river swamp, live oak hammock, turkey oak, flatwoods, pond borders, and bayheads. In all of these, excepting turkey oak where cover was too poor, it was abundant. (See the table.) The largest male and female of a dozen specimens measured, respectively: 187–80–23–15 and 171–74–22–15: weights, 31.0 and 33.7.

Peromyscus nuttalli aureolus (Audubon and Bachman), Southern Golden Mouse.—This mouse was trapped only in a small, dense bayhead at the end of one of the flatwoods ponds. No nest was found there. The three nests found were in the edge of a patch of turkey oak next to the flatwoods, in a thicket of scrub oak between an island of turkey oak and a flatwoods pond, and in a thicket of turkey oak near a dried up pond. A female was taken by hand from the first mentioned, and an inmate was frightened from the second. The nests were roughly globular and smaller than a man's fist. The height above ground varied from about 2 to 8 feet. A male and a female specimen measured, respectively: 149–75–17–14 and 158–71–17–13: weights, 12.0 and 13.5.

Peromyscus floridanus (Chapman), Gopher Mouse.—Gopher mice were taken in the scrub, to which they are rather closely limited. Scrub occurs in rather small areas on the Reserve, and only one of these areas was trapped. No other mice or rats were taken in this area, although gopher mice were comparatively abundant. The largest male and female of six specimens measured, respectively: 184–79–25.5–18 and 207–90–26–19; weights, 28.8 and 35.0.

Oryzomys palustris natator Chapman, Central Florida Rice Rat.—Many nests of this rat were seen supported over the water of flatwoods ponds by emergent maidencane and some other grasses, rushes and occasionally shrubs. In one case an unusual rise in water level had drowned a three-foot pine, and in the security of its dense clusters of dead needles a versatile rice rat had built its nest of the long needles. Frequently the approaching observer would hear a slight rustle and a "plop" in the water which would advise him that the nest had just been vacated. A few rats were seen, and one, instead of disappearing, "froze" for a minute in plain sight in two inches of water and then returned to the nest. Exploring fingers drove the rat from its nest and again it froze at the observer's feet. A lunge to catch the rat caused it to disappear without a ripple. The nest was in a large clump of *Spartina bakeri* which may have concealed some young, although none was in the nest. The larger of two males measured: 313–166–35–14 and weighed 98.6.

Sigmodon hispidus hispidus Say and Ord, Northern Cotton Rat.—On the Reserve cotton rats were taken in flatwoods, pond borders, and river swamp. They were not taken in live oak hammocks, turkey oak, or scrub. According to my trapping records they were the second most numerous terrestrial mammal in the area. In the pellets collected under the nest of the great horned owl, *Sigmodon* remains constituted 10 per cent of one pellet, 30 per cent of another, and occurred in a mass of pellet debris. The largest male and female of eight specimens measured, respectively: 281–124–34–17 and 293–126–31–17; weight 133.1 and 132.5.

Neofiber alleni nigrescens Howell, Everglade Round-Tailed Muskrat.—This little muskrat occurs in a number of the ponds on the Reserve. None of the many efforts made to see this allegedly diurnal mammal moving about in its chosen habitat was successful. Nor was any attempt to catch one alive rewarded. Many of their lodges were examined and, in accord with Harper's (1920, p. 65) findings in the Okefinokee Swamp, it was evident that while some houses contained a bed of soft, rather dry nesting material, the majority did not. The largest of the three male specimens measured: 313–114–43–13 and weighed 203.5.

Rattus rattus alexandrinus (Geoffroy), Roof Rat.—Pierce caught a number of these rats in the laboratory, and Friauf saw others about the storehouse. None was seen or taken in traps away from the buildings.

Sylvilagus floridanus floridanus (Allen), Florida Cottontail.—Cottontails were more

numerous about the buildings than elsewhere on the Reserve, and they seemed at a low ebb of population. Only one was seen by the writer in the whole time spent on the Reserve, although two were taken in traps and tracks were seen occasionally. In the fall of 1940 while this low population prevailed at Welaka, at Gainesville 45 miles west, in three nights of shooting in an acre or two of shrubbery and lawn about his house, Archie F. Carr and some students killed 26. Cottontails frequented turkey oak, live oak hammocks, scrub, and to some extent the less dry flatwoods.

Sylvilagus remains occurred in about half of the 30-odd pellets collected under the nest of the great horned owl. *Sylvilagus floridanus* and *Sylvilagus palustris* remains were both reported, but the owl's nest was in an area more convenient to the habitats of the latter, which, in consequence, probably formed the bulk of the rabbit remains. My estimate, based on these pellets, is that rabbits provided 37 per cent of the diet of the owls. Total mammal remains amounted to about 46 per cent.

A male and a female measured, respectively: 420–55–87–81 and 413–47–87–75.

Sylvilagus palustris paludicola (Miller and Bangs), Marsh Rabbit.—Marsh rabbits were taken twice in steel traps set in four or five inches of water in little pathways through the sphagnum and algae around the edges of ponds. Paths of this sort often extend all the way around a pond branching and anastomosing. Abundant fecal pellets are usual in these paths and in the shrubbery and weed thickets that usually border the ponds. It is believed that a large proportion of this sign is that of marsh rabbits, but a box trap set in a pond border for them caught a cottontail. One male measured: 428–10–85–70.

Odocoileus virginianus virginianus (Boddaert), Virginia Deer.—Observational evidence indicated that there were at least six deer on the Reserve in the fall of 1940, and it seems likely that there were more. Three adult deer were seen together at 10 a.m. in the live oak hammock on October 7, 1940, when the acorn fall was heavy, and at nightfall at Mud Spring on March 26, 1942. In November 1940 Mrs. Dunson saw a buck and a doe with a pair of fawns. Twice that same month and once in January 1940, tracks were observed of a doe with a very young fawn. Tracks indicate that the deer range to all parts of the Reserve, and even show where deer have jumped the six-foot game fence to wander outside.

Sus scrofa scrofa Linnaeus, Pig.—Loose pigs range into the Reserve, particularly the portion adjacent to the river where the game fencing is not complete. There in the obscurity of the swamps they live and reproduce in a wild state, competing with the native wild animals for food. When live oak acorns are falling, the pigs gather and feast daily on them for a month or so. As the crop wanes they root up the whole live oak hammock area. Efforts made to eliminate them from the Reserve have only thinned their numbers.

Trichechus manatus latirostris (Harlan), Florida Manatee.—According to Archie F. Carr, the shallow bulge of the St. Johns River, called Little Lake George, is famous among the fishermen of the river as a feeding area for manatees. The late "Doc" LeFever, former proprietor of a fishing lodge at Welaka, told Sherman of an occasion when he was fishing in Little Lake George and a manatee raised its head beside his boat. Ed Palmer told me of seeing a small sea cow at the mouth of Mud Spring Run on one occasion, and on another occasion, up the run several hundred yards, he saw a sea cow with a "fluke two feet wide and a body as long as my boat."

Sidney Parnell and two other university students were trolling in Little Lake George in September 1939 when they were distracted by an upheaval among the water hyacinths which they believed was caused by manatees. Two large mammals were rolling about under water, tossing the water and hyacinths in what appeared to be mating behavior. At times they were so close to the boat that the students were much concerned lest it be capsized. This behavior took place at eleven in the morning and again at two in the afternoon.

Tursiops truncatus (Montague), Bottle Nosed-Porpoise.—Ilia Tolstoy, general manager of the Marine Studios at Marineland, Florida, writes me that porpoises occasionally reported from the St. Johns River are most likely *Tursiops truncatus* and that he has seen this species himself about Shands Bridge at Green Cove Springs. Sherman saw three or more porpoises

swim under the bridge that spans the St. Johns at Palatka, upstream from the Reserve. Sherman has been told by Jack Russell of porpoises being up the river as far as Sanford.

Dasypus novemcinctus mexicanus Peters, Nine-Banded Armadillo.—While no records of this animal on the Reserve are known, the occurrence of an armadillo has been recorded (Sherman, 1943, p. 56) from Crescent City, Putnam County, about 10 miles east of the Reserve. John Ford of Crescent City tells me of another armadillo which he saw alive that had been taken on the east side of Crescent Lake in Flagler County in 1941. John Collette of Crescent City tells me that armadillos are encountered more frequently on the east side of the lake than on the Crescent City side. J. M. Reynolds of Crescent City has a stuffed armadillo which he killed with a pistol near the Crescent City railroad station in 1940. It was digging under a palmetto trunk to escape a dog when he came upon it. S. L. Shepherd of Pomona tells me that a group of negroes hunting opossum killed an armadillo about halfway between Crescent City and Welaka in March 1942.

LITERATURE CITED

FRYE, O. E. 1941. Studies of the bobwhite quail on the Welaka area. (MS.)

HAMILTON, W. J. 1941. Notes on some mammals of Lee County, Florida. Amer. Midl. Nat., vol. 25, no. 3, pp. 686–691.

HARPER, F. 1920. Florida water-rat (*Neofiber alleni*) in Okefinokee Swamp, Georgia. Jour. Mamm., vol. 1, no. 2, pp. 65–66.

——— 1927. The mammals of the Okefinokee Swamp region of Georgia. Proc. Boston Soc. Nat. Hist., vol. 38, no. 7, pp. 191–396, pls. 4–7.

HOOPER, E. T. 1943. Geographic variation in harvest mice of the species *Reithrodontomys humulis*. Occas. Papers Mus. Zool., Univ. Michigan, no. 477, pp. 19, maps 1.

HOWELL, A. H. 1919. Notes on the fox squirrels of the southeastern United States, with a description of a new form from Florida. Jour. Mamm., vol. 1, no. 1, pp. 36–38.

JACKSON, H. H. T. 1915. A review of the American moles. U. S. Dept. Agric., Bur. Biol. Surv., N. Amer. Fauna, no. 38, pp. 1–100, 6 pls., 27 figs.

LAESSLE, A. M. 1942. The plant communities of the Welaka area with special reference to correlations between soils and vegetational succession. Univ. Florida Publ., Biol. Ser., vol. 4, no. 1, pp. 143, 14 pls.

MAYNARD, C. J. 1883. The mammals of Florida. Quart. Jour. Boston Zool. Soc., vol. 2, no. 1, pp. 1–8; no. 2, pp. 17–24; no. 3, pp. 38–43; no. 4, pp. 49–50.

MOORE, J. C. 1943. Bachman's shrew east of the St. Johns River, Florida. Jour. Mamm., vol. 24, no. 3, pp. 404–405.

——— 1943. A contribution to the natural history of the Florida short-tailed shrew. Proc. Fla. Acad. Sci., vol. 6, nos. 3 and 4, pp. 155–166.

——— 1945. Life history notes on the Florida weasel. Proc. Fla. Acad. Sci., vol. 7, no. 4, pp. 247–263.

RAND, A. L., AND P. HOST. 1942. Results of the Archbold Expeditions, no. 45. Mammal notes from Highland County, Florida. Bull. Amer. Mus. Nat. Hist., vol. 80, art. 1, pp. 1–21.

SHERMAN, H. B. 1937. A list of the recent land mammals of Florida. Proc. Fla. Acad. Sci., vol. 1, pp. 102–128.

——— 1941. A box trap for the capture of live *Geomys*. Jour. Mamm., vol. 22, no. 2, pp. 182–184.

——— 1943. The armadillo in Florida. The Fla. Entomologist, vol. 26, no. 4, pp. 54–59.

SILVER, J., AND A. W. MOORE. 1933. Mole control. U. S. Dept. Agric. Farmers Bulletin, no. 1716.

SOLLBERGER, D. E. 1940. Notes on the life history of the small eastern flying squirrel. Jour. Mamm., vol. 20, no. 3, pp. 282–293.

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NOTES ON THE LONG-LEGGED BAT (*MYOTIS VOLANS*) AT OLD FORT TEJON AND VICINITY, CALIFORNIA

By Walter W. Dalquest and Mary C. Ramage

Relatively little has been published concerning the habits of the large *Myotis* (*Myotis volans*) that ranges over much of western North America. Grinnell (1918) had no information as to the habits of this species. Miller and Allen (1928) mentioned that it preferred relatively open areas; was not social to any degree; and in general avoided caves. Bailey (1936) and Davis (1939) have little to add to previous data. It therefore seems desirable to place on record certain observations made by Mrs. Peggy B. Dalquest and the writers at and near Old Fort Tejon, Kern County, California, where *Myotis volans* is common.

Old Fort Tejon is located in Grapevine Canyon on the slopes of the Tehachapi Mountains, elevation 3200 feet, between Tejon Pass on the south and the San Joaquin Valley on the north. The country is open, with scattered oak trees and grassy hills that, in early June, were dotted with blooming yuccas. One mile northwest the slope of the hills is steeper and there are rock cliffs. Three miles southeast, Castaic Lake occupies a depression in the mountains. A small stream with rather extensive bordering marshes flows from the lake past Old Fort Tejon. Higher on the slopes, the mountains are clothed with piñon and juniper.

We visited Old Fort Tejon on June 2, 1945, in quest of topotypes of *Myotis yumanensis sociabilis* and *Myotis thysanodes thysanodes*. The weather was clear and warm. Preliminary examination of the fort and smaller buildings nearby disclosed no bats. A more intensive search revealed a small colony of *Eptesicus fuscus* and *Tadarida mexicana* beneath the eaves at the southeast corner of the fort. These bats were occupying the space between the old, wooden roof of the building and a newer, galvanized, sheet-iron roof. The bats were in the overhanging eaves outside of the attic.

A colony of approximately 500 *Myotis volans* was found inside the fort. Many bats were in spaces between ill-fitting, overlapping sheets of galvanized iron roofing but most were in the narrow "U"-shaped holes resulting from the contact of the transversely-directed corrugations of the roofing metal against the longitudinal boards of the original roof. The old roofing boards are about five-eighths inch thick and 12 to 18 inches wide. They do not fit tightly together but have spaces of from one-half inch to 3 inches between them. The roof has a 40 degree slope.

The floor of the old fort was cool but the roof was warmed by the sun. We found the air unpleasantly warm in the crevices occupied by bats. The bats were active and could be heard squeaking and scrambling about. Pounding on the boards caused them to emerge and fly about the fort. Some individuals hung up near the top of the end walls but most of them crept into openings similar to those from which they had come. The flight of *Myotis volans* is very similar to that of *Myotis lucifugus* or *Myotis yumanensis*. It lacks the fluttering and soaring typical of the flight of *Myotis thysanodes* or the irregular wing-motion of *Myotis californicus*.

Seventeen specimens were shot or captured as they emerged from crevices. Further search of the fort disclosed three additional *Myotis volans* clinging head-down to overhead beams in the basement at the east end of the building. It was cool in the basement and the bats were rather sluggish.

On June 3rd we visited an abandoned power house situated 1 mile northwest of Old Fort Tejon. This concrete building measures about 30 x 50 feet and is 35 feet high. The roof is of galvanized iron. Some *Tadarida mexicana* were found in the space between thick concrete walls and the metal roof. The roof framework was of scattered 2 x 5 inch boards. Two *Myotis californicus* were found in "U"-shaped openings where the five-inch wide boards lay against the corrugated roof, but other such openings examined were empty. The roofing metal was of squares or oblongs of irregular size. In places, and especially along the ridge pole, the lower section of the metal had sagged, leaving a space. In these spaces we located a colony of *Myotis yumanensis*. The openings were out of reach. Consequently no estimate of numbers present could be made. Some individuals were frightened from their retreats and shot. Of the 15 bats so collected, 14 were *Myotis yumanensis* and one was *Myotis volans*. The presence of the *volans* was not noticed until we had ceased collecting. No outstanding difference in the flight or actions of any one bat could be recollected when the *volans* was detected, 10 minutes later.

About 9:00 p.m. on June 3rd we entered two small buildings behind the Lebec Hotel at Lebec, 3 miles south of Old Fort Tejon. In the first, a 20-foot square room with an open door and window, we found two *Antrozous pallidus*. Both escaped. At the second, a 25-foot square, earth-covered root cellar with a single open door, an *Antrozous* was captured. We returned to the first building, perhaps ten minutes later, and found two *Myotis*. These bats were frightened by our presence and flew about the room in circles at a height of six feet from the ground and a foot from the ceiling. One was captured and proved to be *Myotis volans*. The other retreated to a crevice where, in the beam of a flashlight, it too was seen to be a *volans*.

June 4th was cool and cloudy. We returned to Old Fort Tejon at about 1:00 p.m., arriving in a downpour of rain. The cool weather had made the bats less active and considerable pounding on the roof boards was necessary before the *Myotis volans* took flight. Once a few bats were in flight, however, other individuals emerged more readily. Apparently the squeaking of the bats in flight aroused those still in their retreats. Firing a gun brought hordes of them from their retreats. In contrast to the purposeful flight of these same bats two days earlier, when the weather was warm, the bats seemed dazed. From our position on the rafters we picked bats from our clothes or from rafters a few feet away. Several were snatched from the air as they flew past. They hung in masses at the top of the end walls and a handful was seized at each end of the building. Most of the bats remained near the roof while in flight, but a few descended beneath the rafters to the rooms below. Several flew out windows and one was later found clinging to the outside of the building. About 80 were saved and many more could have been collected.

On the afternoon of June 4 we fitted the doors and windows of the two build-

ings behind the Lebec Hotel with screens from a trash heap. The screens were so arranged as to be hung over all exits to the buildings. The screens were then removed and left standing nearby. Thorough search disclosed no bats in the buildings.

At 9:00 p.m. we visited our "bat traps" to catch such bats as had retired to the buildings to rest. As we approached with flashlights, one or more bats flew out. When the screens had been set up, only a single pallid bat (*Antrozous*) remained to be captured.

At 11:00 p.m. the sky was clear and the air cool. We approached the traps cautiously, without showing lights, and placed the screens. Our traps held 11 *Myotis yumanensis*, 1 *Myotis californicus*, 3 *Myotis volans*, and 3 *Antrozous pallidus*.

A third round of the traps was made at midnight. The early-flying *Antrozous* had retired but the traps held 6 *Myotis yumanensis*, 2 *Myotis volans*, and 1 *Corynorhinus rafinesquii*.

At 3:00 a.m. we found none of the species caught earlier in the evening but 3 specimens of the fringed bat (*Myotis thysanodes*) were taken.

Of the 20 specimens of *Myotis volans* taken at Old Fort Tejon on June 2d, all were females and each had a single fetus, nearly ready for birth. The single *volans* taken from the *Myotis yumanensis* colony, one mile northwest of the fort, was a male. All of the *volans* from the bat traps at Lebec were females. The one saved as a specimen contained a full-term fetus. Of the 82 specimens taken at Old Fort Tejon on June 4th, 81 were females and one was a male. Most of these bats were prepared as specimens the following day. A number had given birth during the night and most of the new-born young were alive. Almost all of the 81 females were pregnant when captured. All of the fetuses were full-term, nearly ready for birth.

All of the *Myotis volans* taken appeared to be in good health. One individual had lost the terminal 25 mm of its tail in an accident. The injury was completely healed. The interfemoral membrane had contracted and "pouched" about the scar but was flexible and normal in appearance. This bat was pregnant, fat, and apparently normal in other respects.

Myotis volans, unlike most species of western *Myotis*, seems prone to heavy parasitism. At least 12 bedbugs were found in the series of 104 adult bats. Never was there more than one bedbug on a bat. The bedbugs were all in approximately the same position; attached to the forearm or wrist with body lying back between the digits or between the last digit and the forearm. The most unusual parasite was a large crab-louse. Every specimen of *Myotis volans* examined by the writers soon after death had two of these lice attached to the rectum about 1 mm inside the anus. These lice were dark in color and the size of a pinhead. A few mites and wingless flies and a single flea were noted. These parasites have not yet been identified.

LITERATURE CITED

BAILEY, VERNON. 1936. The mammals and life zones of Oregon. U. S. Dept. Agric., North American Fauna, no. 55, 416 pp., 52 pls., 102 figs.

DAVIS, W. B. 1939. The recent mammals of Idaho. Caldwell, Idaho: The Caxton Printers, Ltd., 400 pp., 2 pls., 32 figs.

GRINNELL, H. W. 1918. A synopsis of the bats of California. Univ. Calif. Publ. Zool., vol. 17, pp. 223–404, pls. 14–24, 24 figs. in text.

MILLER, G. S., JR., AND G. M. ALLEN. 1928. The American bats of the genera Myotis and Pizonyx. U. S. Nat. Mus., Bull. 144, pp. viii + 218, 1 pl., 1 fig., 13 maps.

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TECHNIQUES FOR THE STUDY OF THE NORWAY RAT (*RATTUS NORVEGICUS*)

BY DENNIS CHITTY AND MONICA SHORTEN

For studying the efficiency of control measures, estimates of absolute density are of less importance than the relative size of the original and residual populations. Several hundred such measured tests have been carried out by our colleagues and ourselves, the results of which will be published later. The present paper deals only with a small part of an extensive piece of team work carried out by the Bureau of Animal Population, Oxford University, under a grant from the Agricultural Research Council. In the course of this work the feeding behavior of the Norway rat (*Rattus norvegicus*) was studied, with results of general biological interest.

THE CENSUS BAITING METHOD

A relative census technique has been described in which wild populations of brown rats are offered wheat in excess of their daily requirements (Chitty, 1942). When other animals are present rodent-specific containers must be used, and success largely depends on placing these to intercept the rats before they reach their normal food supplies. In most infestations wheat is found to be attractive, and there is little difficulty in drawing the rats away from their usual food. After a build-up period the amount eaten remains relatively constant from day to day and the size of the population may then be expressed in terms of the consumption of wheat. As a certain amount of alternative food may continue to be taken, the consumption of wheat shows only the minimum feeding capacity of any colony, although as a rule there appear to be 3–4 rats per 100 g of wheat.

Foods for attracting animals may be given in excess of their consumption (surplus baits) or in small amounts that are entirely eaten (token baits). These baits may be used to attract animals for study or as prebaits in order to increase the success of subsequent poison baits or trapping.

A surplus of food may also be offered before and after a control operation but solely as a method of census. This is termed a census prebait and postbait. For example, the efficiency of prebaiting and poisoning in rat holes is tested as follows: containers, if needed (see Chitty, 1942; Doty, 1938; Ministry of Food, 1944b), are placed at several points and after a few days' lag before the rats enter them, a surplus of wheat is placed and measured daily until a peak

has been passed and feeding is steady. This census prebait is discontinued, the holes are prebaited and poisoned, for example with sugared flour and arsenic (Ministry of Food, 1944b), after which a census postbait is carried out with wheat in the containers. Success is judged by the percentage reduction in wheat consumption, but because of the variability of conditions in rat colonies it is usually necessary to do at least six such standard trials on each poison or baiting system.

Thus there are the following kinds of baits: (1) baits to attract animals for observation, photography, food choice experiments; (2) prebaits to improve the success of poisoning or trapping; (3) poison baits; (4) census baits, including census prebaits and postbaits when given before and after a control operation. There should always be a surplus of poison and census baits, but the others may be surplus or token baits. In Hawaii surplus baiting is done before and after poisoning (Doty, 1938), but in Great Britain token prebaits are laid (Ministry of Food, 1944a, 1944b; Morgan, Fisher and Watson, 1943) and a surplus is used only in research. At times surplus prebaiting may obviously fulfil several functions.

A FOOD RECORDING MACHINE

In a small rat colony or one that lacks adequate alternative food, the majority of rats can be baited at a single point and a 24 hr. record of wheat consumption obtained with the recording machine described below. Table 1 and figs. 1 and 2 give the main results from a winter and summer series of records at a small pig farm close to a rubbish dump and railway. The rats were entirely wild, but probably more numerous than they would have been without the wheat, which, over a long time, had become their chief food. Under these circumstances the population was feeding very largely at the food recorder, and though a certain amount of alternative food was eaten as well, the available quantities were small.

These rats were free from human disturbance (other than passing trains) except for 2–3 hr. between 9 a.m. and 6 p.m. or, in summer, 7 p.m. *by the clock*. However, when well fed, they took very little of their food in the daytime, and as a rule only the undisturbed period 6 or 7 p.m. to 9 a.m. needs detailed consideration.

For comparing feeding rates on different days, it is most convenient to plot total grams (g) wheat eaten by the end of each ½ hr. This cumulative total may also be expressed as a percentage of the total night's take when populations of two different sizes are being compared. For the winter population the curve averaged from two week's records of surplus baiting (a, fig. 1) gives a remarkably straight line from about 6 p.m. when it was dark and quiet until about 7 a.m., two hours before sunrise. During these two weeks the average daily consumption was 1734 g of wheat (range 1590–1920 g); in addition, an average of 16 g was eaten between 9 a.m. and 6 p.m.

At the end of these two weeks, the rats were given only 300 g token baits at 6 o'clock on each of five evenings. There is little doubt that the balance

PLATE 1

UPPER: Rats on a rubbish dump taking token baits of wheat from pipe bait containers, late afternoon, August 1941. (The first observation on response to token baits: made by Mr. Charles Elton.) *Photo. H. N. Southern.*

LOWER: Rats in an empty pigstye coming out to feed on token baits of wheat, early afternoon, July 1944. The background has been limed to give contrast for photography. *From the Crown Film Unit's production "Killing Farm Rats".*

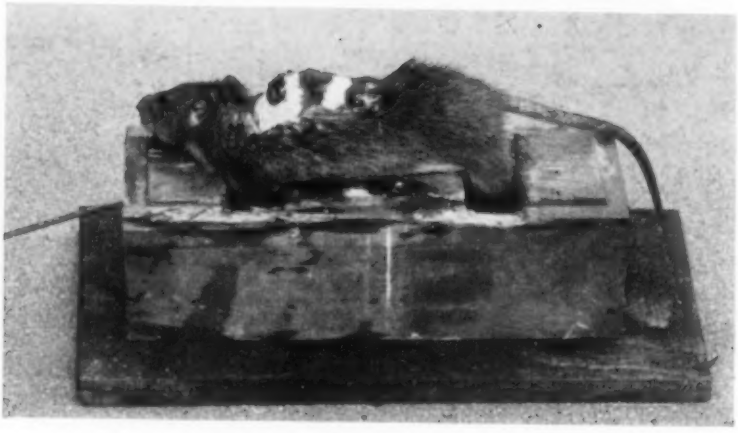

PLATE 2

UPPER: A large rat scooping up a mouthful of wheat before returning to cover. The background has been limed. *From the Crown Film Unit's production "Killing Farm Rats".*

LOWER: A rat with "5" marked on its back with depilatory. Each pair of legs is bound together with adhesive tape and a wire passes between them. *Photo. H. N. Southern.*

TABLE 1.—*Cumulative total of wheat consumed (% of total consumption)*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	12–20 DEC. 1941 & 2–7 JAN 1942	12/13 JAN. 1942	27/28 JAN. 1942		10–20 JULY 1942	19/20 AUG. 1942	30/31 JULY 1942	
	p.m./a.m.	p.m./a.m.	a.m./p.m.	p.m./a.m.	p.m./a.m.	p.m./a.m.	a.m./p.m.	p.m./a.m.
6	0	0	—	7.67	0	—	—	44.2
6:30	5.67	4.56	—	9.94	0.26	—	—	45.0
7	10.28	15.64	—	15.34	0.51	0	—	46.0
7:30	14.89	28.01	—	25.85	1.28	1.29	—	49.0
8	18.79	29.64	—	30.68	2.31	11.15	—	51.0
8:30	21.99	32.57	—	37.50	4.11	20.68	—	54.4
9	25.53	33.55	—	42.61	6.43	27.30	—	56.0
9:30	29.08	37.46	—	44.32	8.74	33.60	—	57.0
10	31.91	39.74	0	48.01	11.31	40.87	0	57.4
10:30	36.17	42.02	0	52.84	13.88	47.82	1.8	58.8
11	41.13	45.60	0.14	53.69	16.71	48.47*	6.8	61.6
11:30	43.62	47.56	0.14	55.40	22.11	51.86	11.8	63.4
12	46.81	50.81	0.42	57.67	31.36	55.90	16.8	65.6
12:30	50.00	54.07	0.71	58.24	38.30	61.23	21.0	69.2
1	54.26	60.91	0.99	61.08	44.21	65.11	23.4	73.4
1:30	57.80	62.87	2.13	67.05	48.33	68.17	25.4	77.6
2	61.35	66.78	3.27	71.59	52.70	70.44	27.6	82.8
2:30	64.54	70.03	3.56	74.43	56.30	74.64	28.4	—
3	67.38	72.96	4.55	74.43	61.44	78.84	28.4	—
3:30	70.92	74.27	4.97	75.85	66.06	83.36	31.0	—
4	75.18	76.22	5.26	78.41	72.23	89.18	33.6	—
4:30	80.14	77.52	5.40	82.67	78.92	94.18	36.2	—
5	85.11	83.06	6.11	84.09	86.63	97.58	37.8	missing
5:30	89.36	84.36	6.68	87.50	92.28	99.03	41.4	
6	94.33	89.58	7.67	88.92	95.88	99.52	44.2	
6:30	97.52	95.11	—	94.32	97.68	99.52	—	
7	99.64	97.72	—	96.02	98.45	99.84	—	
7:30	99.64	99.67	—	98.30	98.71	99.84	—	—
8	100.00	100.00	—	99.15	99.23	100.00	—	—
8:30	100.00	100.00	—	100.00	99.74	100.00	—	—
9	100.00	100.00	—	100.00	100.00	100.00	—	—
Consumption (g)								
9 a.m.–6 p.m., 16	—	172	—		33	—	1490	—
6 p.m.–9 a.m., 1734 ..	1888	—	2173		2622	4171	—	c. 1880
Total 24 hr., 1750	1888	2245			2655	4171†	c. 3370	
Range, 1590–1920	—	—			2400–2925	—	—	
Sunrise, 9:03–9:12	9:07	—	8:51		5:57– 6:09	5:56	—	6:25
Sunset, 4:53–5:10	5:19	5:44	—		10:14–10:22	8:22	9:59	—

* Interruption to refill pipe.

† Population increased since July.

Columns 2 and 6 during surplus baiting; columns 3 and 7 after previous token baiting in the evening; columns 4, 5, 8 and 9 after previous token baiting in the morning. Times are clock times: British Summer Time (G.M.T. + 1 hour) except for Double British Summer Time in July.

was not made up by scavenging, although floors, buckets and pig troughs were now thoroughly searched for food scraps. Hunger produced a change in feeding pattern which is most clearly shown on the night when a surplus of wheat was restored (b, fig. 1): both initial feeding rate and total consumption were high. Thus out of 1888 g total, the amount taken in the first 1½ hr. was 529 g (28%) compared with the usual 258 g—15% of the smaller average total. This was followed by a take of only 1445 g.

A week later token baits were given again, this time for seven days at about 10 a.m. After the first 300 g token bait, a few rats began to feed earlier in the day: 3:30 p.m., 12:50 p.m., noon, and thereafter as soon as it became quiet.

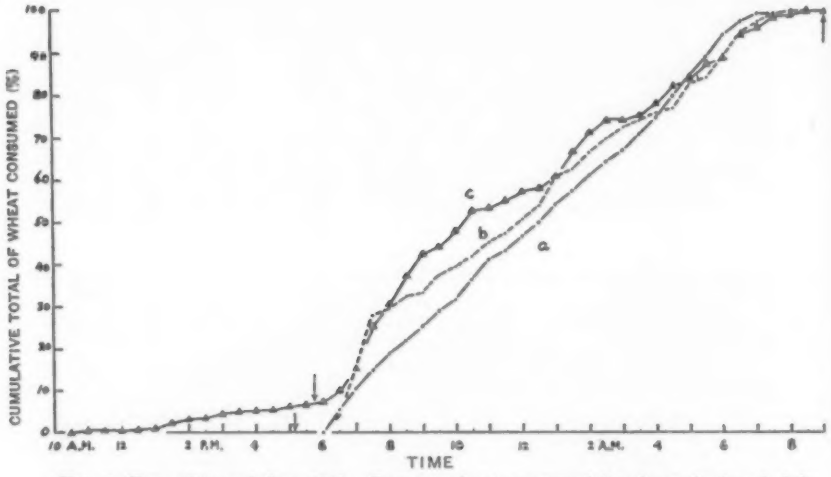

FIG. 1. Dec. 1941 and Jan. 1942. Percent wheat consumed by the end of each ½ hr. (a) Average of 15 days surplus baiting (neglecting 1% consumed 9 a.m. to 6 p.m.) (b) The first night of surplus baiting after five days token baiting at 6 p.m. (c) The first day of surplus baiting after seven days token baiting at 10 a.m. Arrows show approximate times of sunset and sunrise.

However, feeding was slow and intermittent until dark, as shown by c in fig. 1, for the day a surplus was restored (at 9:40 a.m.). Between then and 6 p.m. human activity was confined to 1½ hr.; yet only 172 g were eaten. By next morning the total take was 2245 g—a definite "hunger peak"—followed by a low take of 1500 g, presumably because of satiation.

Similar experiments were carried out the following July and August, using 1000 g token baits on a larger population with two or three times the capacity for wheat as in the winter. The average of 10 days surplus feeding rates (a, fig. 2) gave an S-shaped curve resulting from slow feeding in the light evenings, rapid feeding by dark, and a gradual tailing off from just before sunrise. Hunger resulting from token baiting in the evening brought about extremely rapid

feeding before sunset (b, fig. 2), but the change is less striking than it might have been because the clock had been put back 1 hr. and sunset was also earlier. More in contrast to the results in January was the effect of token baiting at 10 a.m. after which more than 40% of the 24 hr. consumption occurred before 6 p.m. (c, fig. 2). Hunger peaks followed by lower takes occurred on both occasions.

In November 1943 we succeeded in completely inverting the feeding rhythm: there was 100% take between 11 a.m. and 6:30 p.m. and no further feeding until next morning. So far there is no explanation for the refusal of the population in January 1942 to feed well by day (even in a dark shed), but a similar refusal has been found elsewhere. The hunger peak after token baiting is also typical of many other colonies where food is scarce.

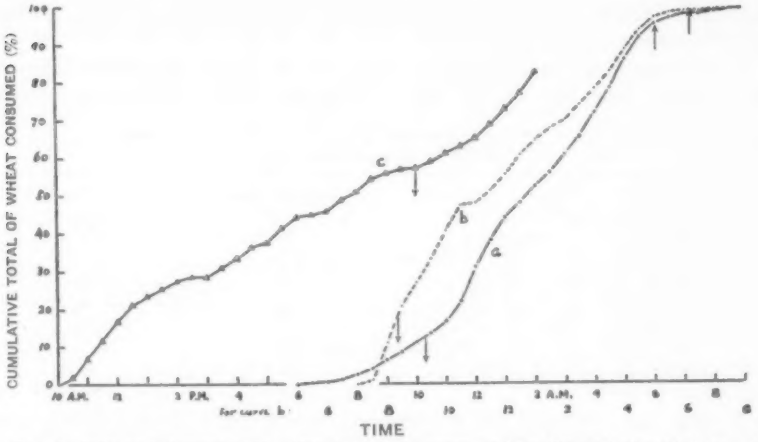

FIG. 2. July and August 1942. Percent wheat consumed by the end of each ½ hr. (a) Average of ten days surplus baiting (neglecting 1% consumed 9 a.m. to 6 p.m. D.B.S.T.). (b) The first night of surplus baiting after seven days token baiting at 7 p.m. B.S.T. (= 8 p.m. D.B.S.T.). (c) The first day of surplus baiting after six days token baiting at 10 a.m. D.B.S.T. Arrows show approximate times of sunset and sunrise.

WATCHING

In many undisturbed places where rats are sufficiently hungry and have not too strong a nocturnal habit they can be conditioned to taking token baits at any regular time of day (Plate 1). For the purpose of watching their behavior an old shed at the pig farm has been divided off into an observer's compartment and a "stage" ruled into a grid for plotting positions. Rats can also be observed throughout the night by means of a light placed about 3 ft. away from their food. To conserve the 6 volt battery, a 3 watt light is maintained in series with a time-clock: but for watching, a 24 watt light can be used if needed. The rats quickly adapt themselves to the lights and feeding records after the first night are no different from those made in darkness.

There is great individuality about the way different rats approach their food, but in general some settle down in one place and feed for 1–50 minutes and others, after quickly seizing a mouthful of wheat, (Plate 2) run away to eat it under cover. (The noise of feeding sounds like several typists at work.) No evidence of stored grain was ever found. There is a continual change in numbers of rats on the stage and occasional mass exits may leave it empty. In one period of 5 minutes a single line was crossed 154 times to and from the food.

The total number of visits to the food in each 5 minute period provides the most useful data. As examples, some experiments are quoted on how rats react to new situations. There is abundant field evidence that changes in the environment or the bait often reduce the daily consumption at surplus baiting stations. Watching has shown that this is because of the hesitant approach even to small and harmless new objects or to familiar objects in a new position. Automatic records show that this behavior is strongly displayed even in complete darkness.

At 8:40 one night an old piece of wood 7 in. by 3½ in. was placed between the entrance hole and surplus bait. There had been considerable feeding

TABLE 2.—*Number of passages (counted in one direction only) Artificial light, 5 June 1941*

TIME (D.B.S.T.)	VISITS TO FOOD	PART-WAY VISITS	VISITS ELSEWHERE
8:30–36	48	13	0
8:40	piece of wood placed		
9:00–06	0	6	3
–12	0	5	0
–18	0	7	7
9:20	piece of wood removed		
9:40–46	48	14	0

until then and a control interruption had shown that normal activity was quickly resumed. During the next 40 minutes, however, only two small rats went over the wood. Two larger rats rushed towards the food but stopped suddenly; some crept up very slowly, nose extended, hind legs well out behind them, sniffed the edge of the wood and withdrew. Otherwise the rats mostly stayed at the entrance hole, frequently raising their noses high into the air. It can easily be understood how the belief has arisen that human smell is a deterrent; however, these actions are shown even if the new object has not been handled. Activity came back to normal once the wood was removed. Counts were made for 6 minute periods at the times shown in table 2.

A similar test was done on token baited rats. Wheat normally placed on the floor of the shed was placed in a shallow metal tray. After much inspection, mostly from a distance, the rats gradually disappeared and no food had been taken 3 hours later (table 3).

The strength and duration of this reaction varies greatly between individuals and populations. Its effect may last less than 1 hour and not depress the total daily consumption, or there may be no feeding for several days. Therefore

bait containers must be placed 1–2 weeks before measurements begin and be kept in the same positions throughout. We owe much of our knowledge about the extraordinary manifestations of this behavior to the late Mr. R. M. Ranson.

MARKING

When details are needed about individual rats, each must have a clearly visible identification mark. Part of the population is live-trapped, the fur on the back or flanks is clipped down to ⅛ in. and a number is marked out with a depilatory so that the light colored flesh shows through this dark underfur. This technique was developed in conjunction with Mr. A. D. Middleton.

The most convenient way of handling the rats is to etherize them, bind together with adhesive tape first the front legs and then the back. The rat is then placed on a small box with a hole in the top for each pair of legs and a wire is run along the underside of the wood to pass between them (Plate 2). No

TABLE 3.—*Number of passages (counted in one direction only)*
Daylight, 24 Dec. 1943

TIME (B.S.T.)	VISITS TO FOOD	PART-WAY VISITS	TIME (B.S.T.)	VISITS TO FOOD	PART-WAY VISITS
11:13 a.m.	Wheat placed on floor				
11:13–15	5	0	11:40–45	0	44
–20	36	3	–50	0	42
–25	63	0	–55	0	32
–30*	58	2	–00	0	16
11:30	Wheat placed in tray		12:00–05 p.m.	0	21
–35	0	26	–10	0	14
–40	0	6†	–15	0	12

*Control interruption at 11:25.
† Activity depressed by a noisy locomotive.
Total wheat consumption: 80 g. in 162 visits i.e. ½ g. per mouthful.

more ether is required until the depilatory has been washed off under the tap and the rat is ready to be unbound. The great disadvantage of the technique is that the marks may last only for 2–3 weeks, but this has proved long enough for our experiments. A formula for the depilatory is 7 parts, by weight, barium sulphide, 7 flour, 7 French chalk, 1 Castille soap powder. This is moistened and applied with a spatula.

On several nights in February 1944 a colony of rats was studied in which a random sample of 11 marked rats ranged in body weight from 200–400 g. The feeding visits of each individual were counted from 7 p.m. to 10 p.m. or midnight and once until 8 a.m. Activity was often so great that it was impossible to look away long enough to make notes and the following system was therefore adopted. A roll of paper was mounted on the right hand side of a board 6 in. by 14 in. and the tape passed through a guide, as in a typewriter. Every time a rat appeared its number was entered in the guide space which was easily located by touch. The paper was then wound ½ in. onto a wheel turned by the

left hand and the time was marked in every 5 min. by watching a clock on the stage.

There was a striking difference between the behavior of rats after token and surplus baiting. When hungry, more rats started feeding simultaneously; individuals were less intermittent and ate faster than when surplus baited (table 4 and fig. 3).

The ratio of visits by marked and unmarked rats was observed on three nights. During the all-night observations (on the fifth night of surplus baiting) 960 g wheat were eaten in a total of 2109 visits; 54% of these were made by marked rats and 58% and 60% on the shorter occasions. Assuming a random distribution of feeding behavior, the population therefore consisted of about 20 rats with an average consumption of 48 g.

TABLE 4.—*Feeding behavior of marked rats*

	NO. OF RATS WHICH HAD BEGUN FEEDING WITHIN 15, 30 AND 60 MINS. FROM PLACING OF BAIT			DURATION AND RATE OF FEEDING DURING 1 HR. AFTER ARRIVAL OF EACH RAT	
	15 min.	30 min.	60 min.	No. of 5 min. periods	Mouthfuls per active period
(a) *Average of 11 rats*					
Token (2 nights)	6.5	9	10	9	5.4
Surplus (4 nights)	2.5	6	8	5.2	3.3
(b) *300 g. female No. 5*					
Token (5 Feb.)	—	x	—	8	12.6
Surplus (7 Feb.)	—	x	—	5	5.6
(c) *260 g. female No. 7*					
Token (5 Feb.)	x	—	—	12	5.3
Surplus (7 Feb.)	—	—	x	4	2.2

x = period of arrival.

This figure can be checked independently, previous observations, as in table 3, having shown that the average size of a mouthful of wheat is between 0.35 and 0.50 g. (On this occasion it was 0.455 g.) Since the 11 marked rats made 1133 visits their average wheat consumption would be expected to lie between 36 and 51.5 g. These are higher values than were found by Mr. P. H. Leslie for Norway rats in large outdoor cages, where animals of corresponding weights would have consumed a daily average of about 30 g of wheat. Similar figures found by us in a few wild populations suggest that there were special circumstances (now being studied) to account for the larger appetites of the pig farm colony.

There was a great deal of variation between the behavior of different individuals. The most unusual was a 190 g male which often failed to appear in the first part of the evening and took only nine mouthfuls during the one entire night. Another animal had at first refused to feed from the prebait point and got all its food by stealing from other rats or scavenging what they dropped.

It was characteristic of certain rats to eat from the wheat without taking it away in mouthfuls; but such visits were few and short in this population and can have introduced little error into the figures. Dr. J. Rzóska has similarly found great "individual behavior" in white rats' reactions to baits and poisons. On various nights during surplus baiting, five different rats each took a single mouthful and did not return to the bait until after the following intervals: >1, 1½, 3, 3¼, 3½ hr. During surplus baiting there was no pronounced evidence of feeding rhythm and many rats spread out their visits over a considerable

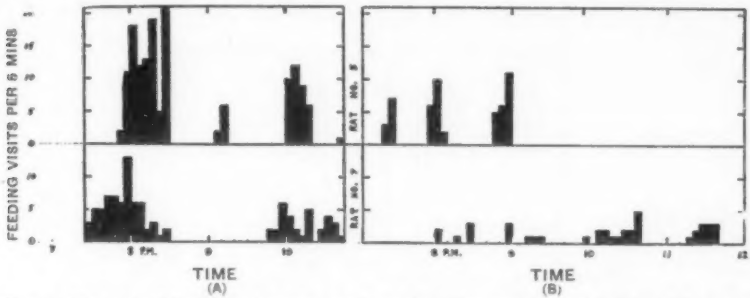

FIG. 3. No. of feeding visits by two rats in each 5 min. period. (a) 5 Feb. 1944. After four days token baiting at 7 p.m. Rat No. 5 (300 g. ♀): 2, 11, 18, 12, 13, 19, 5, 21 (101)—2, 6—10, 12, 9, 6—1. Rat No. 7 (260 g ♀): 3, 5, 5, 7, 7, 6, 13, 6, 6, 2, 3, 1 (64), 2—2, 2, 6, 4, 2, 1, 5, 0, 2, 4, 3, 1. (b) 7 Feb. 1944. After two days surplus baiting at 7 p.m. Rat No. 5: 3, 7—6, 10, 2 (28)—5, 6, 11. Rat No. 7: 2—1, 0, 3—3 (9)—1, 1, 1—1, 0, 2, 2, 1, 1, 2, 2, 5—1, 2, 3, 3, 3.

— = break of > 5 min. Brackets show totals for 1 hr. after first appearance.

TABLE 5.—*Census prebait at two localities (g. wheat eaten)*

LOCALITY	ALTERNATIVE FOOD	APRIL 1944					
		19	20	21	22	23*	24*
Barn	Plentiful	275	275	140	210	232	233
Poultry pen	Scarce	560	250	290	230	287	288

*Averaged.

part of each evening (fig. 3 b); but during baiting on Feb. 5 there were two bursts of feeding 1–2 hr. apart (fig. 3 a).

DESCRIPTION OF FOOD RECORDING MACHINE

Rate of consumption of wheat can be measured throughout the 24 hours by means of an apparatus consisting of a hopper filled with wheat and a clockwork recorder.

The hopper (fig. 4).—A pipe stands in an inverted cone within a framework made from a large tin can supported on four legs. Depending on the amount

of bait required, pipes of 1–4 in. internal diameter are used. Because they are encased by the cone and tin can, different pipes can be used during an experiment without causing a change in behavior. Each pipe is held upright by a piece of wood cut to the right sized hole. The wood for the 4 in. pipe (a glazed drainpipe) is fitted across inside the tin can and adapters are screwed on when the other sizes are in use.

As the rats remove it from the tray, wheat is delivered through the apex of the cone and a weight slides down inside the pipe. The weight is a piece of metal tubing, or a tin can filled with plaster of Paris and has three fins to keep it centered: for its diameter must be about half an inch less than that of the

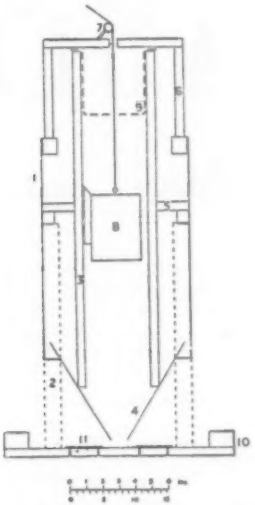

FIG. 4. Center section of the hopper. The tin can (1) is supported by legs (2) at the four corners. The pipe (3) stands in the cone (4) and is held upright by the holder (5). To fill the pipe the mounting (6) for the pulley (7) is removed, also the weight (8). The wire (9) is inserted and wheat added to this level. Rats feed on the tray (10). The plugs (11) are removed during calibrations. Scale: Approximately ½.

pipe, or wheat grains will get jammed between the weight and pipe. Because of friction with the pipe the outside of the column of wheat is held back and gradually rises up the sides of the sinking weight.

The recorder (*fig. 5*).—A cotton thread attached to the weight passes over two pulleys and is clipped onto a smoked strip of paper which is pulled along a channel on a board. Lying face downwards over the channel is a specially adapted clock: its glass has been removed, each hand has been strengthened and carries a small glass tube at right angles to the face. The tube on the minute hand describes a circle of 10 mm radius; that on the hour hand must describe a larger circle (19 mm radius) or it could not pass between the face of the clock and the minute hand.

Sticking out of the lower end of the glass are "nibs" made from the points of $\frac{1}{8}$ in. diameter nails. The nibs have freedom of movement up and down, exert only the pressure due to their own weight and so do not tear the paper unless they have been filed to too sharp a point.

Interpreting the records (*fig. 6*).—When the paper is stationary the nibs mark out two concentric circles. The marks are made in an anti-clockwise direction, the inner one being completed every hour, the outer every 12 hours. When the paper is moving in one direction under the clock the pattern traced by the minute nib will be a series of loops, and a center line drawn in later will be

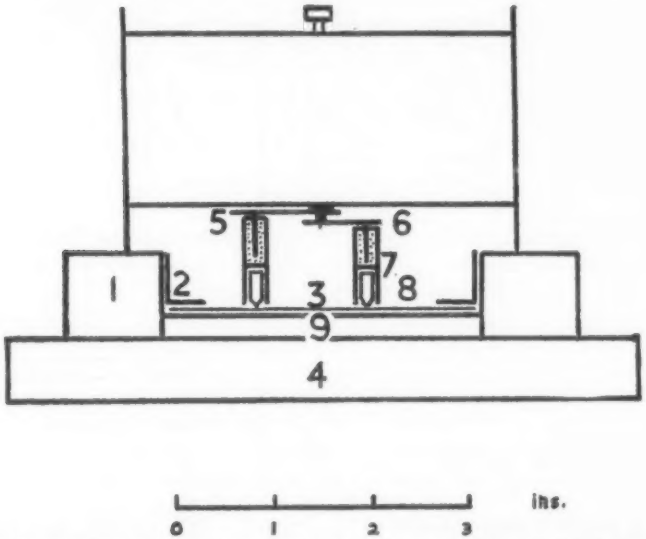

FIG. 5. Center section of the clock. The sides (1) of the channel, with the guides (2) for the paper (3) are nailed to the board (4). The hour hand (5) and minute hand (6) have been strengthened to carry a prong to which a glass tube (7) is fixed (with paraffin wax) enclosing the nib (8). The bed of the channel is raised (9) so that the paper will not catch at the crack between (1) and (4).

crossed at the hours and half hours. During feeding, the weight pulls the paper along so that at each hour this nib crosses the center line some distance below the previous right to left crossing. Similarly, each left to right crossing at the half hours will show a displacement from the previous left to right crossing. These movements are measured by laying a ruler down the center line with its zero at the hour position made by the minute hand before feeding began. After the displacements at the hours have been read off, the zero on the ruler is moved down the diameter and the half hour displacements are read.

Before feeding starts there is an unknown number of circles superimposed on each other and without the hour hand it would be impossible to know when

feeding started or what time was represented by any of the minute hand tracings. Now when the hour hand crosses the center line at 12 o'clock the minute hand is also crossing it 9 mm below. This point is easily found on a tracing and the other times are arrived at from this datum. Alternatively a piece of celluloid is used, scratched with the hour and minute hand circles and divided into 12.

Daily routine.—The paper strips are made from standard $5\frac{3}{4}$ by 20 in. glazed paper used by physiologists. These sheets are cut in half lengthwise and

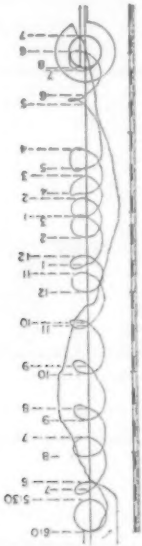

FIG. 6. Record of wheat consumption at a pig farm. 4/5 Jan. 1942. 4 in. pipe. The strip was inserted at 3:56 p.m. and removed at 5:57 p.m. next day. The scale on the left is 33 cm long. Figures on the extreme right are times at the half hours; those to the left of them are times at the hours. Displacements of the paper in mm. were as follows (6.15 g. per mm):

At the hours 6:0–9:0 p.m.	0			25			46			69		
At the ½ hrs. 6:30–9:30 p.m.		11			38			57			83	
Displacements per ½ hr.	11		14	13		8	11		12			14

blackened on a tin drum revolving over a paraffin burner. The finished strip is unclipped, the mounting for the pulley over the hopper is removed and the weight pulled out. A piece of wire shaped like a flat-bottomed U is hung down inside the pipe which is refilled from a weighed quantity of wheat to the level of the wire. The weight of wheat required equals that eaten by the rats since the pipe was last filled. The wire is removed and weight and pulley mounting are replaced. The fresh strip is attached with gummed paper underneath the bottom edge of the old one. As the latter is removed the new strip is pulled into position, then disengaged and clipped to the thread; the clock is

wound and a circle made with the minute hand to mark the zero position (once round then back again). On the finished tracing the time at the hours and half hours is then marked in, other relevant data are added and the strip is immersed in shellac solution. (Brown shellac, flaked: 100 g, 96% alcohol 2000 cc, castor oil 65 cc. Two parts of this are diluted with one of 96% alcohol).

Calibration.—With uniformly mixed stock of wheat there is a fairly good linear relationship between the displacement of the paper and the quantity of wheat removed (except towards the end). To establish this the hopper is raised off the ground and wheat is pushed out through an opening on each side of the center of the tray by moving a thin strip of wood back and forth under the cone. Samples of wheat are weighed and the minute hand of the clock is moved round once each time thus giving the g. wheat. removed per mm displacement of the paper. The values so obtained agree with those from refilling the pipe each day and dividing this amount by the total displacement of the paper. With the 4 in. pipe in the summer of 1942, 1 mm represented 6.74 g. Graphs can be plotted in mm.

DISCUSSION

These techniques have contributed to rat control in two ways: directly by showing the factors for and against successful poisoning and indirectly by the light thrown on the relative census data obtained in field trials. Much has been learned about the general biology of the Norway rat and it is hoped that the methods will prove useful in studying other mammals. We have not been successful in adapting ear tags (MacLulich, 1937; Trippensee, 1941; Southern, 1940) or color marking (Evans and Holdenreid, 1943; Fitzwater, 1943) to the identification of individuals without retrapping.

As rat populations differ so considerably, it is unlikely that the curves (a) in figs. 1 and 2 are typical of the feeding behavior of all well-fed rats. In fact two other shapes of curve have been derived from work at the pig farm: (1) In June 1941 the rats fed rapidly in the early evening and by sunset had eaten twice the proportion of wheat eaten in the same interval in July 1942. (2) For a few days in February 1943 there was an extraordinary burst of feeding between 6 a.m. and 10 a.m. when up to 45% of the 24 hour total was taken.

Where natural food is adequate, rats may not respond to token baits in the same way as when it is lacking. Thus, in January 1943, after the pig farm colony had been temporarily reduced, there was no rapid feeding or hunger peak after token baiting with wheat. The natural food supply was about the same as usual but enough for the smaller number of rats.

A similar contrast was provided by two small tests, one at some poultry pens where there was no obvious alternative food; the other in a barn 70 yards away where the rats used to take bread and oats from rabbit hutches and scraps left over by cats. Both colonies were token baited simultaneously for five days and then given a surplus of wheat. Where there was plenty of food there was no hunger peak, and the succeeding takes of wheat possibly represented more rats than at the poultry pens where total takes were similar (table 5). For

example in the barn more alternative food than usual was probably eaten on April 21 when wheat consumption dropped 50%. Although with two such different populations there is a variable error in comparing relative densities, this does not affect the comparison of relative success in poisoning. This and other evidence about interpreting the figures requires a lengthier discussion elsewhere.

SUMMARY

Surplus baiting with wheat has been used by the Bureau of Animal Population to census wild rat populations, especially before and after tests with poisons. For a proper interpretation of the data and also of the factors involved in poisoning, rats' feeding behavior must be understood.

Automatic half-hourly records of wheat consumption have shown the predominantly nocturnal habit of well-fed rats even in a quiet environment. Where food is inadequate rats can often be conditioned to feed rapidly on token baits at any one time of day, although occasionally this response is only shown at night.

It is possible to watch rats' feeding habits, behavior towards changes in the environment or the food, and other actions. There is sometimes a lengthy adjustment to certain types of change, but baited rats quickly get used to artificial illumination and can be watched by night.

For short-term studies on rats, individuals can be marked by making numbers with a depilatory in their fur. It is then possible to determine total population and average individual consumption of bait.

While most rats in a colony become well baited, others show peculiarities such as indifference to the bait or long absence after a single mouthful. This accounts for the survival of certain rats after poisoning.

LITERATURE CITED

Chitty, D. 1942. A relative census method for brown rats (*Rattus norvegicus*). Nature, London, vol. 150, pp. 59–60.

Doty, R. E. 1938. The prebaited feeding-station method of rat control. Hawaii. Plant. Rec., vol. 42, pp. 39–76.

Evans, F. C., and R. Holdenreid. 1943. A population study of the Beechey ground squirrel in central California. Jour. Mamm., vol. 24, pp. 231–260.

Fitzwater, W. D., Jr. 1943. Color marking of mammals, with special reference to squirrels. Jour. Wildlife Mgt., vol. 7, pp. 190–192.

MacLulich, D. A. 1937. Fluctuations in the numbers of the varying hare (*Lepus americanus*). Univ. Toronto Stud. Biol., no. 43, pp. 1–136.

Ministry of Food. 1944a. Standard methods of rodent control. Pharm. Jour., vol. 152, pp. 222–223.

———. 1944b. Extermination of rats and mice. London, pp. 1–8.

Morgan, M. T., J. Fisher, and J. S. Watson. 1943. Rodent control in the area of the Port of London Health Authority. Med. Officer, vol. 70, pp. 37–38 & 45–46.

Southern, H. N. 1940. The ecology and population dynamics of the wild rabbit (*Oryctolagus cuniculus*). Ann. Appl. Biol., vol. 27, pp. 509–526.

Trippensee, R. E. 1941. A new type of bird and mammal marker. Jour. Wildlife Mgt., vol. 5, pp. 120–124.

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NO SEASONAL BREEDING CYCLE IN DOGS

By Earl T. Engle

There is little information on the periodicity of the estrous cycle among dogs. While it is stated that the dog has two estrous periods in the year, in the spring and in the autumn (Marshall, 1922, and Dukes, 1942), dog breeders are unaware of any seasonal incidence.

Whitney (1927) reported some most interesting observations on estrus and ovulation in the dog, together with records of birth dates of over 2000 German Shepherds. While no clear seasonal differences were observed, there were more conceptions from February to August than from August to January. Unfortunately, Whitney's article appeared in a popular publication devoted to the hunt and has not been widely read.

To obtain further information, the birth records of 3754 dogs of five breeds were studied. The data were obtained from the American Kennel Club Stud Book Register, mostly from the twelve issues of the 1943 Register; a few are from 1942. These data give the pertinent facts of date of birth and parentage.

The dog is listed in the Register alphabetically by name, under the breed. Several pups from the same litter may be registered under different means by different owners in the same issue or in separate issues. In recording the birth dates, an effort has been made to list only one pup from a litter. In the listings of the English and Irish Setters and the Great Danes, this recording was probably quite successful, but it is less so with the Pekingese. It is certain that litter mates are recorded in these data as shown in the tables, but they are not numerous and because of the large number of dogs should not affect the validity of the data.

The publication of name and registry number in any issue of the Registry appears to be a true random sample since some dogs are registered at birth and others after 1½ or 2 years. Only original registry is noted. Dogs previously registered and subsequently noted for transfer of ownership are not included. Dogs bred or whelped outside of the United States are not included.

The breeds chosen for study were Cocker Spaniels, Great Danes, English and Irish Setters, and Pekingese. These were selected to give a wide sampling among the many dog breeds. The Cocker is the most widely distributed and most numerous pure line dog in the United States. It is a hardy animal, surviving well in a city apartment or in the field. The Great Dane is represented by much fewer numbers and is not the most desirable dog for congested city life. The Setters are largely suburban or country owned, and many of them, especially the English Setter, are field trained dogs. The Pekingese is almost entirely a house dog. Indeed it may be said that it rarely lives a dog's life.

The date of conception, as shown in the tables, was determined from date of birth on the basis of a 2-months (60 days) gestation period. Actually, gestation may vary between 59 and 63 days.

No data from this source are avalaible for a study of the estrous cycle. Only those cycles that result in a completed pregnancy can be determined from these

records. Since a dog can be mated only when in estrus, the data in the tables show only when fertile matings were made. The special interests of the practical dog breeder probably influence the figures presented here.

The month of conception for each of these breeds is recorded in Table 1. The season of conception shown in Table 2 is derived from the data in Table 1, but the year is divided into quarters. December, January and February are the winter months, the other seasons are in sequence. This method does much to eliminate errors of calculation of date of conception based on a 60-day period of gestation.

TABLE 1.—*Conceptions by months in four breeds of dogs*

BREED	MONTHS												TOTAL
	12	1	2	3	4	5	6	7	8	9	10	11	
Cocker Spaniel	45	71	63	71	75	96	95	128	128	122	77	54	1025
Great Danes	50	38	65	78	65	50	52	58	61	69	55	49	690
English and Irish Setters	65	81	99	126	113	103	103	86	69	73	47	49	1014
Pekingese	49	79	106	99	85	88	107	80	94	71	87	80	1025
Total	209	269	333	374	338	337	357	352	352	335	266	232	3754

Table 1 shows the calculated number of conceptions for each breed and the total for all breeds by month. Fertile estrous cycles occurred in relatively uniform numbers in each month. The greatest number of fertile matings recorded were for March, when approximately 10 percent of the yearly conceptions occurred. The least number recorded was for December, when less than 6 percent of the yearly conceptions occurred.

The data of Table 2 indicate that almost twice as many conceptions occurred among Cocker Spaniels in the summer quarter as in the winter. Almost twice as many conceptions occurred among the Setters in the spring as in the fall. It is probable that these differences may represent deliberate breeding control as a result of practical considerations. The female can be bred only when in estrus, but a cycle may be passed without mating for special reasons. Breeders who handle and train Setters may not desire pregnant or lactating bitches during the fall hunting season. It is not to be assumed that these seasonal differences in conceptions represent the true biological status of estrus.

The disparity in constitutional types and conditions of life between the Great Dane and the Pekingese is very great indeed, yet in the periodicity of reproductive performance they are similar. The larger breed has quite large litters and the Pekingese usually has small ones. Both in a sense are luxury dogs. In neither is there any indication of a significant seasonal periodicity of conception.

In addition to the breeds represented in Table 1, small samplings were taken of birth dates of Boxers, Collies, St. Bernards and Newfoundlands. These showed a lowered incidence in the winter quarter, but the variations were of the same order as represented here.

Evans and Cole (1931), in their study of the estrous cycle of the dog, made

on a small number of animals collected at the city pound in Oakland, California, state that ". . . we did not encounter marked seasonal differences in the incidence of heat in females of the mongrel canine population of this locality." Since the climatic effects might be reflected in seasonal estrous rhythms, the birth dates of the Cocker Spaniel were analyzed in relation to geographical areas. All births were recorded for the group of Spaniels for each of the following areas, New England, East Atlantic, Central, South, Rocky Mountain and Pacific Coast. The percentage of conceptions by month or by season showed no significant difference between geographical areas.

TABLE 2.—*Conceptions by seasons in four breeds of dogs*

BREED	WINTER		SPRING		SUMMER		FALL	
	No.	%	No.	%	No.	%	No.	%
Cocker Spaniel	179	17.5	242	23.6	351	34.2	253	24.6
Great Dane	153	22.2	193	27.9	171	24.8	173	25.0
English and Irish Setters	245	24.2	342	33.7	258	25.4	169	16.7
Pekingese	234	22.8	272	26.5	281	27.4	238	23.2
Total	811	21.6	1049	27.9	1061	28.2	833	22.2

The estrous cycle of pure bred dogs of diverse breeds appears rather uniformly throughout the year. Such variations as are shown in these data may represent the control of the animal breeder as much as an inherent seasonal periodicity of the breed or the species.

LITERATURE CITED

DUKES, H. H. 1942 The physiology of domestic animals 5th edition. Ithaca, N. Y. (p. 678).

EVANS, H. M. AND H. H. COLE 1931 The oestrous cycle in the dog. Memoirs of the Univ. Calif., vol. 9, no. 2, pp. 65–118.

MARSHALL, F. H. A. 1922 The physiology of reproduction. Longman Green, London.

WHITNEY, L. F. 1927 The mating cycle of the dog. The Chase, July, pp. 65–118.

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SOME HELMINTH PARASITES OF SKUNKS IN TEXAS

By Jack D. Tiner

Presented in this paper are the results of a study of the helminth parasites of the striped skunk *Mephitis mephitis varians* Gray, the spotted skunk *Spilogale leucoparia* Merriam, and the hog nosed skunk *Conepatus mesoleucus mearnsi* Merriam. The work was done in the Department of Veterinary Parasitology, Texas Agricultural and Mechanical College, under the direction of the late Dr. H. L. Van Volkenberg.

The bulk of the parasites examined in this study came from viscera of skunks trapped for food analysis by the Texas Cooperative Wildlife Research Unit. The animals were trapped in Kerr and Mason counties of the Edwards Plateau of central Texas, and the stomachs and intestines were preserved in formalin. Student workers found 170 out of about 400 skunks to contain helminth parasites. An additional specimen was collected at College Station, Brazos County. Skulls of all skunks in the Texas Cooperative Wildlife Collections were examined for nematode lesions in the frontal sinuses.

In addition to the thornyheaded worms, the following parasites were found:

TAPEWORMS	ROUNDWORMS
Oochoristica sp.	*Physaloptera maxillaris* Molin 1860
Mesocestoides sp.	*Filaria martis* Gmelin 1790
Species not identified	*Molineus* sp.
	Skrjabingylus chitwoodorum Hill 1939 (presence indicated only by lesions)

ANALYSIS OF DATA

Oochoristica sp.—An anoplocephalid tapeworm, probably *Oochoristica oklahomensis* Peery 1939 was present in more than half of the specimens.

Mesocestoides sp.—This worm occurred less frequently than *Oochoristica*, the ratio being about three to seven. Ninety-seven were taken from the skunk collected at College Station.

Physaloptera maxillaris.—Almost all parasitized skunks contained this roundworm. It was present in 155 of the 170 skunks, averaging 27 worms per animal. According to Dr. Banner Bill Morgan (personal communication, 1943) the occurrence of this species in *Spilogale leucoparia* is heretofore unreported.

Filaria martis.—Drs. Asa C. Chandler and E. W. Price checked and confirmed this identification. Two vials containing filariids from the subcutaneous tissue were in the collection. One consisted of a mass of worms taken from *Conepatus*, the other, two specimens from *Mephitis*. Dr. Price (personal communication, 1945) states that there is a sample of *Filaria martis* in the U. S. N. M. Helm. Coll. from a "skunk" from Benton, Texas, collected by A. J. Kiss, January 30, 1926. The writer and his correspondents have found no previous report of this nematode in skunks.

Skrjabingylus chitwoodorum.—Lesions of what is assumed to be an infestation with this parasite were found in skulls of three *Spilogale* and three *Mephitis*. Damage varied from a marked bulging and osteitis over the frontal sinuses to actual holes in one or both of them. Corresponding openings in the skin which had covered these skulls were not found. The *Conepatus* examined were free from injury. Also, there were no lesions in skunks collected in the Trans-Pecos region of Texas.

Molineus sp.—Three trichostrongylids were found in one vial. Insufficient specimens were available for species identification, but according to Dr. Morgan (personal communication, 1945) they belong to the genus *Molineus*.

Acanthocephala.—Specimens of thornyheaded worms were sent to Dr. H. J. Van Cleave, University of Illinois, for determination.

SUMMARY

Six kinds of parasites were recovered from stomachs and intestines of about 170 skunks of three genera collected in Texas. So far as could be determined, *Molineus* sp. is previously unreported in skunks. *Filaria martis* is reported for the first time from *Coneaptus mesoleucus* and *Mephitis mephitis*. *Physaloptera maxillaris* has not been reported previously in *Spilogale leucoparia*.

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GENERAL NOTES

WINTER FOOD HABITS OF THE PINE MARTEN IN MONTANA

During the winter of 1942–43 the writer had the opportunity of serving as leader of the Fur Survey for Montana Federal Aid Project #1R in cooperation with the Research Division of the U. S. Fish and Wildlife Service. Field work was carried on by a six-man crew in the North Fork Fur Management Area which lies west of and adjacent to Glacier National Park. The area is bounded on the other sides by the Canadian border, U. S. Highway 93, and the Great Northern Railway.

During the period from November 15, 1942 to April 8, 1943, 46 pine marten (probably *Martes americana*) scats were collected. The crew of the previous year collected eighteen scats in the same area. The following table summarizes the frequency of occurrence of food items in the two sets of data. Determinations were all made by William H. Stickel of the U. S. Fish and Wildlife Service.

Tracks in the fresh snow indicated three kills of red squirrel, one of flying squirrel, and one of *Canachites franklinii* during the second winter.

These data reaffirm the statements of many authors concerning the importance of the red squirrel in the marten's diet. They also indicate that flying squirrel, red-backed mouse and snowshoe hare—three other small mammals of northern forests—are of considerable importance at least during the winter period. Bird life was of minor value. The deer hair was undoubtedly carrion as may well have been the case with the song birds. The occurrence of lichen, which made up the bulk of one scat, and of grass, which was appreciable in three scats, indicates a casual use of these items.

Unfortunately no data are available on comparative numbers of the prey species. Based on general impression the red squirrels were very abundant, as were the snowshoe hares in local areas of favorable cover. One common small mammal that does not appear in the food items is the weasel, of which both the long-tailed and the short-tailed species

Table showing frequency occurrence of items in Pine Marten scats by percentages

	WINTER 1941–42	WINTER 1942–43
Total number scats	18	46
Tamiasciurus hudsonicus	45	35
Glaucomys sabrinus	10	25
Clethrionomys gapperi	15	14
Lepus americanus	20	5
Odocoileus spp.? (carrion)	5	5
Bonasa umbellus	5	—
Tetraonidae spp.?	—	4
Passeriformes spp.?	—	4
Coleoptera spp.?	—	1.5
Alectoria fremontii (lichen)	—	1.5
Gramineae spp.?	—	5
Total items	20	57

(The contents of three scats obtained during the second winter were unidentifiable. Three others contained in part materials which were camp refuse.)

were present. Grouse were certainly not common and were also highly localized in their distribution. The deer were on winter ranges well removed from the marten habitat.—WILLIAM H. MARSHALL, *University Farm, St. Paul 8, Minnesota.*

A NOTE ON THE BEHAVIOR OF THE PRONG-HORNED ANTELOPE

On June 16, 1945, while driving north along the graveled highway between Vya and Mud Lake in Washoe County, Nevada, during mid-afternoon of a bright sunny day, a medium large buck antelope was standing near the middle of the road leisurely and contentedly watching our approach. He stood his ground until our automobile, traveling at a speed of about 35 miles per hour, was within 30 or 40 yards of him. The car was actually slowed down to avoid a possible collision with the buck, when he leisurely turned and started running up the middle of the road, where, within a few yards he deliberately leaped into the air. The action was so sudden and unexpected that my companion exclaimed, "See him kick up his heels; he wants to play." To our astonishment, he again made a sudden leap. After several more leaps, we realized what was wrong with our antelope. A few yards to the west of the road was a telephone line, with poles set every 200 feet. Each pole cast a definite, clearly marked shadow across the road. Our antelope was jumping well over each and every one of these shadows and he kept it up every 200 feet for slightly over a mile. Many times I have seen startled and frightened antelopes pause to crawl under barbed wire fences. Evidently the shadows were a new kind of obstruction to the mind of this antelope. He could not crawl under them, so he jumped over them.—STANLEY G. JEWETT, *Portland, Oregon.*

FOUR RED BATS IN ONE LITTER

On July 5, 1945, a female northern red bat (*Lasiurus borealis borealis*) with four young—two females and two males—was captured in Lincoln, Nebraska. Professor M. H. Swenk, in his unpublished notes on Chiroptera states that in several litters he had observed, "there were only two or three young."

These bats were taken into the laboratory and examined before being released in a small elm tree. The female was unable to fly with four young. The two young males were left in the tree by the female for two days. On the second day they were cold and it was feared

they had been abandoned. They were fed artificially for a few days but failed to mature. —Doris B. Gates and Jeanne Wolcott, *Department of Entomology, University of Nebraska, Lincoln 1, Nebraska.*

NOTES ON BATS FROM EASTERN WEST VIRGINIA

The following notes are mostly of a distributional nature and serve to supplement the studies of Surber (1909), F. E. Brooks (1911), A. B. Brooks (1929), Kellogg (1937), Wilson and Friedel (1941). Although the records listed are mostly from Hardy County, it seems advisable to include Hampshire, Grant, and Pendleton counties. These counties are situated in that part of West Virginia drained by the Potomac River.

The ectoparasites listed were identified by Dr. J. C. Bequaert and Ensign E. W. Jameson, Jr., USNR. Mr. J. Kenneth Doutt identified or confirmed the species of bats. Through the cooperation of the curators of Mammals of the Carnegie Museum and Cornell University Museum, I was supplied with lists of those specimens in their collections from this area.

Myotis lucifugus lucifugus (Le Conte).—This is the most common species of bat in eastern West Virginia. It is an inhabitant of caves as well as buildings, particularly the older and larger buildings of the area. They are abundant in the attics of the churches and homes erected prior to, or after, the Civil War. In Hardy County, near Moorefield, a colony of these bats, inhabiting the attic of Oakland Hall, a large house erected before the Civil War, has been systematically studied for parasites. As far as I have been able to ascertain, there have been bats in this attic for almost 80 years. Of a total of 100 specimens collected during the summers of 1942 and 1943, 51 were found to be infested with the flea, *Myodopsylla insignis insignis*; 19 with the bedbug, *Cimex adjunctus*; and 21 with mites of the genus *Spinturnix*. The mites were always found on the wing membranes. Of this series of bats only one was of the interesting bronze color.

Seven additional specimens were obtained from behind the shutters of a brick house in Moorefield. Three of these were infested with the engorged larva of a recently described tick, *Ornithodoros kelleyi* Cooley and Kohls. This appears to be the first report of this species of tick for West Virginia.

Myotis keenii septentrionalis (Trouessart).—During October, 1944, a young lady, residing in Moorefield, Hardy County, was waked during the night by a bat flying repeatedly over her head. The intruder, which was killed and brought to the author, proved to be of this species. Measurement of the specimen, a male, are: total length, 89 mm; tail, 39 mm; foot, 8.5 mm; and forearm, 36.5 mm.

A. B. Brooks (1927, p. 540) has recorded one specimen from Braxton County, which is supposedly in the British Museum, and Kellogg (1937, p. 448) lists two specimens from Aurora, Preston County. The Hardy County specimen, therefore, is the fourth record for the state and the first for the eastern panhandle.

Pipistrellus subflavus subflavus (F. Cuvier).—The Georgian bat, quite common in the caves of eastern West Virginia, is often found in company with *Myotis l. lucifugus*, *Eptesicus f. fuscus*, and sometimes *Corynorhinus r. rafinesquii*. Specimens have been collected in Grant, Hardy, Hampshire, and Pendleton Counties. Reese (1934, p. 50) and Kellogg (1937, p. 449) have reported this species from Smoke Hole Cave and Franklin in Pendleton County.

Lasiurus borealis borealis (Müller).—During the author's field work in eastern West Virginia, the red bat seldom has been encountered. A solitary specimen was observed on October 20, 1944, flying over a forest clearing at a camp near Largent, in Hampshire County. The animal was finally collected with a 12 guage shotgun but was not preserved. Kellogg (1937, p. 449) has recorded one specimen from Franklin, Pendleton County.

Lasiurus cinereus (Beauvois).—A. B. Brooks (1929, p. 541) states that this bat is reported as occurring in West Virginia, and Surber (1909) lists it as a migrant; neither writer cites definite records. The collection, therefore, of a female at Moorefield, Hardy County, appears to be the first authentic record for West Virginia. The specimen was found on the

morning of September 28, 1944, lying on the sidewalk where it had apparently fallen from a nearby tree.

Eptesicus fuscus fuscus (Beauvois).—The big brown bat has been commonly found in attics and under the eaves of buildings, as well as in caves and crevices in cliffs. During August of 1944, in Hardy County, it was frequently observed flying at midday over the South Branch of the Potomac River. In October, 1944, two specimens were collected in Baker's Cave, near Durgon, in Hardy County, in company with *Pipistrellus* and *Corynorhinus*. An additional specimen collected in Moorefield was found to be infested with the engorged larvae of *Ornithodoros kelleyi*. There is one specimen in the museum at Cornell University collected in Pendleton County.

Corynorhinus rafinesquii rafinesquii (Lesson).—Two specimens of the big eared bat were collected in Baker's Cave, near Durgon, in October of 1944. Authentic records of this bat in West Virginia are restricted to Pendleton, Randolph, Preston, and Hardy counties.

The Baker Cave specimens were infested with the parasitic fly *Trichobius corynorhinii* Cockerell.

LITERATURE CITED

BROOKS, A. B. 1929. Mammals of West Virginia. The West Virginia Encyclopedia xxiv + 1052 pages.

KELLOGG, REMINGTON. 1937. Annotated list of West Virginia mammals. Proc. U. S. Nat. Museum., vol. 84, pages 443–479.

REESE, A. M. 1934. The fauna of West Virginia caves. W. Va. Univ. Bull., ser. 34, no. 15 (Pro. W. Va. Acad. Sci., vol. 7) pages 39–53.

SURBER, THADDEUS. 1909. Some remarks on the game mammals of West Virginia. Proc. 3rd. Annual Meeting W. Va. Fish and Game Prot. Assoc., pages 49–56.

L. WAYNE WILSON, *Moorefield, West Virginia.*

MULE DEER ATTACKS YOUNG CANADA GEESE

The morning of June 20, 1942, a commotion was noted at 5:00 a.m. in a pen at the "P" ranch buildings on the Malheur National Wildlife Refuge, Harney County, Oregon, where four young Canada goose goslings (*Branta canadensis*) were kept with their foster mother, a domestic hen. Investigation revealed that a two point buck mule deer (*Odocoileus hemionus*) was chasing the goslings and hen and trying to jump on them. It was subsequently chased away. At about 9:00 o'clock the evening of June 21 a neighbor lady, Mrs. Matt Morgan, heard a commotion in the vicinity of the goose pen. Going out she saw a young buck after the goslings and chased it away. At about 5:00 o'clock the next morning Mr. Matt Morgan noted what was apparently the same buck attempting to jump on the goslings. He watched it a short while thinking it was just playing before chasing it away. It may be that the deer was playing but in a rather rough manner as far as the goslings were concerned. This activity was deemed somewhat unusual and one wonders what percentage of mortality in the wild is caused by similar incidents.—CLARENCE A. SOOTER, *U. S. Fish and Wildlife Service, Alice, Texas.*

THE DAYTIME RETREAT OF A CALIFORNIA MASTIFF BAT

On May 2, 1945, Miss Mary Ramage and the writer discovered a mastiff bat (*Eumops perotis californicus*) at Silver Creek, 7½ miles east southeast of Panoche, San Benito County, California. This is near the northern edge of the range of the species, although H. W. Grinnell (Univ. Calif. Publ. Zool., vol. 17, no. 12, pp. 223–405, 1918) reported a specimen from Fresno, California, and von Bloeker (Jour. Mamm., vol. 24, no. 4, pp. 403–404, 1943) recorded specimens from still farther north and west, in Monterey County. Most published records of this bat mention individuals found in buildings or collected while in flight. The following note on its natural daytime environment may be of interest.

At the above listed locality, Silver Creek is a rather slow-moving, alkaline stream

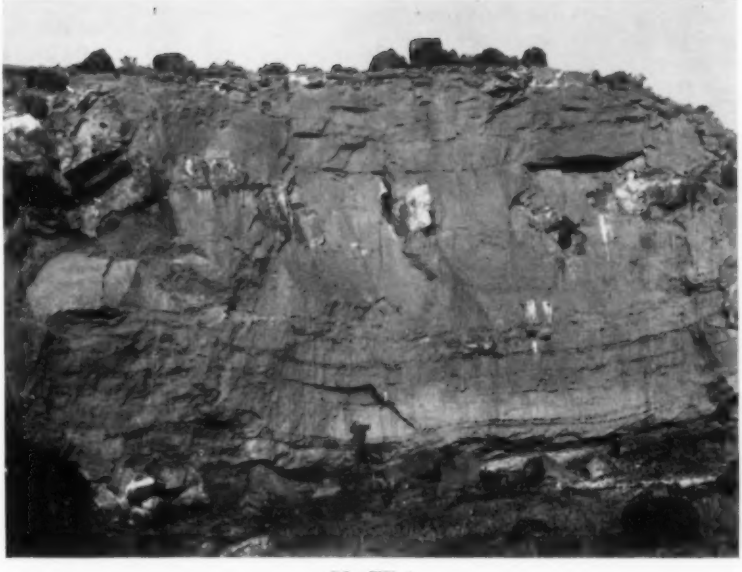

PLATE 1

TOP: Ventral view of a mastiff bat from Sierra Madre, Los Angeles County, California (Mus. Vert. Zool. Photo 1093).

LOWER: A sandstone cliff 7½ miles east southeast of Panoche, San Benito County, California. The angular crevice (lower middle) was the daytime retreat of a mastiff bat. (W. W. Dalquest photo).

averaging, at the time of our visit, about 4 feet in width and 6 inches in depth. It flows through an area of soft shale and loose sandstone strata. Cliffs of these soft rocks occur at intervals along the stream valley. Concretions, varying from a few inches to many feet in diameter, have weathered from the sandstone layers and lie as round boulders in the stream bed. Shallow caves show where concretions have weathered out of the cliffs and the cliff-faces are pitted by wind and water. These openings, in addition to numerous crevices formed by fractures of the cliff rock, offer shelter to bats.

The hills above the cliffs are smoothly rounded and clothed with sparse dry grass. The grass was brown and the soil parched on May 1, indicating the arid condition of the locality in summer. In the creek valley, brome grass and black sage (*Salvia mellifera*) form the principal vegetation. Mammals other than bats and pocket gophers were extremely scarce. We saw one cottontail and one ground squirrel (*Citellus beecheyi*) in two days' hunting while 300 trap-nights caught only two deermice. Reptiles of desert types were common.

The feces of the *Eumops* were found as we searched for bat droppings beneath crevices in the cliffs. The feces were first mistaken for those of a small wood rat but closer inspection showed them to be more irregular in shape with bits of insect chitin visible in places. About 25 feet above the droppings, a yard-thick slab of sandstone leaned from the cliff and formed an angular crevice 15 feet long and 3 to 5 inches wide. A beam of sunlight was reflected into the crevice and disclosed the bat hanging head down about 3 feet above the opening. When wounded with a charge of dust shot, it screamed and chittered in a loud, shrill voice. The bat was an adult male with a wing-spread of 21 inches. The mummified body of another *Eumops* was removed from the same crevice. Other species of bats collected within 100 feet of the daytime retreat of the *Eumops* included: *Myotis subulatus melanorhinus*, *Myotis thysanodes thysanodes*, *Pipistrellus hesperus merriami* and *Tadarida mexicana*.—Walter W. Dalquest, *Museum of Vertebrate Zoology, Berkeley, California.*

A MUSKRAT HOUSE ON THE LOWER COLORADO RIVER

On November 22, 1944, while we were checking beaver and muskrat (*Ondatra zibethica bernardi* Goldman) abundance on the Imperial National Wildlife Refuse approximately 30 miles north of Yuma, Arizona, on the lower Colorado River, a muskrat house was observed.

Grinnell (*An Account of the Mammals and Birds of the Lower Colorado Valley*, Univ. of Calif. Publ. Zool., vol. 12, no. 4, p. 237, 1914) stated, "No signs of houses were seen anywhere, the muskrats appearing to resort entirely to holes in the banks where the current was sluggish." On page 737, volume 2, of *Fur-Bearing Mammals of California*, 1937, by Grinnell, Dixon and Linsdale, is found this statement, "We have observed that the muskrats of the Colorado River and Imperial Valley never build houses, but live entirely in burrows, underground."

The house noted by us was constructed of lengths of cut *Typha* and located in a thick growth of the dominant cat-tails or "tules" in a quiet "lake" or backwater above Picacho on the western side of the main river channel. The stems forming the foundation of the abode were laid parallel for the most part and wedged between standing plants which were growing in water 2½ to 3 feet deep. The one central shelter or room consisted of a small dry nest of finely shredded cat-tails located at the top of the cut tules a few inches above the high water mark. This room was but a small part of the entire structure which covered an area of approximately 2½ x 3½ feet. Several local muskrat trappers state that although a few such houses do exist in this area they are not numerous. It is noted that this muskrat construction is not as elaborate as the muskrat dwellings of more northerly latitudes well described by Hamilton (*American Mammals*, 1939, pp. 218–220).

In recent years the series of dams constructed on the lower Colorado has had a stabilizing effect on the flow of the river. The extreme seasonal floods of this stream as described by Sykes (*The Colorado Delta*, Carn. Inst. of Washington and Amer. Geo. Soc. of New York, 1937) and others have, to a large extent, been eliminated. Above the Imperial Dam (com-

pleted in 1938) in the area under discussion are now found large expanses of quiet backwaters that have fairly stable year-round water levels. These acreages are, however, in many cases, rather rapidly filling with silt and vegetation. It is possible, therefore, that changing conditions of habitat have had an effect on the local muskrat population and a few houses are now being built in restricted suitable environments that did not exist when the lower Colorado River was entirely uncontrolled and more subject to extreme seasonal floods with the resultant widely fluctuating water levels.—ARTHUR F. HALLORAN, *Fish and Wildlife Service, Yuma, Arizona.*

WATER SHREW FROM POTTER COUNTY, PENNSYLVANIA

Four specimens of the water shrew, *Sorex palustris albibarbis*, were caught near Carter Camp, Post Office, Potter County, Pa., on the northeast slope of Mount Broadhead, on one of the head waters of Little Kettle Creek, at an altitude of 1663 feet. This locality extends westward in northern Pennsylvania the known range of this shrew.

All the specimens, two males and two barren females, were taken from May 21 to June 21, 1945, from the same place—a small spring that runs from the side of the hill under a maple tree that is forked at the ground level. One fork stands upright; the other, covered partly with moss, lies along the ground for 15 feet then turns upward for about 25 feet.

The little spring runs from under the part of the tree on the ground and is about 5 inches across at one outlet and about 3 inches across at an other, with only a few inches of ground between the two. The water level never varies.

The surrounding area is a narrow, dark, damp hemlock hollow, with moss-covered hemlock logs criss-crossing each other. The creek takes up most of the bottom of the hollow. The chief plants, besides hemlock, are shinleaf, jewel weed, Indian pipe, naked mitrewort, creeping buttercup, rough bedstraw, partridge berry, marsh fern, turtlehead, and moss.

I had five traps set only a few inches apart and baited with bacon rind. Other mammals taken at the same spring, which holds not much more than a saucerful of water, were short tailed shrew, meadow mouse, jumping mouse, white-footed mouse, pine squirrel and chipmunk. Also, an olive-backed thrush, a large toad and a wood frog were taken in the traps.

All specimens are in the Carnegie Museum, Pittsburgh.—MARY WIBLE, *Carter Camp, P.O., Potter County, Pennsylvania.*

A RECENT RECORD OF THE YUMA MOUNTAIN LION IN ARIZONA

Grinnell, Dixon, and Linsdale (*Fur-Bearing Mammals of California*, Univ. of Calif. Press, vol. 2, p. 587, 1937) could find no positive record of the Yuma mountain lion (*Felis concolor browni*) since 1909. It seems appropriate, therefore, to record a recent occurrence of this subspecies. On February 17, 1944, William Casto, a hunter of the Fish and Wildlife Service, trapped a mountain lion in the Kofa Game Range, about 50 miles northeast of Yuma, Yuma County, Arizona. The animal was taken near Squaw Tank, in the Kofa Mountains, in country well over 1000 feet above sea level and of typically rough desert terrain.

The specimen was submitted to the Carnegie Museum for identification and under date of April 28, 1945, Caroline A. Heppenstall, Assistant Curator of Mammalogy wrote concerning it, in part, as follows: "The data on the original tag of the Mountain Lion in question are as follows: male; total length, 2070 mm; tail, 787 mm; hind foot, 292 mm; weight, 125 lb.; . . ."

"The skull measurements are: Greatest length of skull, 205 mm; condylobasal length, 187.1; basilar length, 166 mm; palatilar length, 76 mm; zygomatic breadth, 141.1 mm; mastoid breadth, 86.1 mm; breadth across postorbital processes, 105 mm." The subspecific character of this very old individual was definitely established by J. Kenneth Doutt, Curator of Mammalogy, Carnegie Museum.

Inquiry was made of E. M. Mercer, Predator and Rodent Control Division, Fish and Wildlife Service, Phoenix, Arizona, relative to southwestern Arizona records of mountain

lions. His letter of April 24, 1945, stating that their files contained no records from the lower Colorado River area, excepting the specimen under consideration, emphasizes the rarity of this subspecies.

During the past winter and spring (1944–45) old signs of mountain lions have been noted in the Kofa Game Range and a few reports of sight records from the Imperial National Wildlife Refuge, Arizona, on the lower Colorado River have been received, but to date no other specimens have been taken.

The cover of the September 1944 issue of the *Arizona Wildlife and Sportsman* carried a picture of this mountain lion taken following its capture.—ARTHUR F. HALLORAN, *Fish and Wildlife Service, Yuma, Arizona.*

RECORDS OF WOLVERINE FOR WISCONSIN AND MINNESOTA

Records of wolverine (*Gulo luscus*) for Wisconsin are few and none too definite. Mather (Forest and Stream, vol. 51, p. 109, 1898) states that during the winter of 1855–56, he trapped in western Wisconsin with an old Canadian, Antoine Gardapee, and took two wolverines on the Bad Axe River, Vernon County. Two chapters of his book (Men I have Fished With, Forest and Stream Publishing Co., N. Y., pp. 200 and 217, 1897) give circumstantial accounts of the capture of the two wolverines.

The library of the Wisconsin Historical Society contains a typed copy of the Journals of Rev. E. F. Ely, the originals being in the custody of the St. Louis County (Minnesota) Historical Society. On March 24, 1837, he left Fond du Lac (Superior) for Sandy Lake, Minnesota, by way of the St. Louis River. The entry for March 25 reads: ". . . A multitude of tracks crossing & recrossing . . . the river . . . of Rabbits principally . . . Minks & fisher . . . at Vshkibuaka, saw a fisher crossing . . . just ahead. A little farther on . . . saw a Wolverine coming toward us on the Ice. He did not discover us. When quite near we lay down upon the Ice. About 8 or 10 Rods distant, he stopped . . . looked at us, & again approached . . . stopped again . . . & took alarm & ran. William sprang upon his feet . . . flourished his hatchet . . . ran after him a few rods uttering a *Yell* that only tended to quicken the animal's speed. We could see him for a Mile or more, pursuing his run up the River."

The Milwaukee Public Museum contains two mounted specimens of the wolverine labeled "Wisconsin," but without further data. C. B. Cory (Mammals of Illinois and Wisconsin, p. 355, 1912) says they "may or may not have been actually taken in the state." The Wisconsin Historical Society has a letter written July 5, 1876, by Charles Mann to A. L. Kumlien, Busseyville, Wisconsin, asking him what he would charge to mount the skins of two wolverines from Colorado. Mann was corresponding secretary of the Natural History Society of Wisconsin, predecessor to the Museum. It therefore seems very improbable that the Museum's specimens are of Wisconsin origin.—A. W. SCHORGER, *Madison, Wisconsin.*

WEIGHTS OF A MINNESOTA MOOSE

Comparatively few exact weights of many of our large game mammals are recorded. It, therefore, was thought advisable to place on record the following data, although somewhat incomplete, on a moose taken October 18, 1944, about 15 miles south of Roosevelt, in Lake of the Woods County, Minnesota. This specimen, a vigorous young bull judged to be five or six years old, was taken for a habitat group in the Minnesota Museum of Natural History. The animal was shot in a sedge swamp bordered by low spruce and jack pine-covered ridges. It was taken out to a headquarters camp on a stone boat or skid drawn by a caterpillar tractor where it was weighed on two platform scales. All these facilities were the property of the State Conservation Department. The data are thus made available through the much appreciated cooperation of that department.

Measurements in feet and inches: Total length, 8; height at shoulder, 5–11; chest girth of carcass, 6–3; spread of antlers, 3–8.

Weights in pounds: Heart, 5; remaining viscera (stomach ¼ full), 234; hide, 80; remainder of carcass, 720; total weight on scales, 1039; blood loss, 26; total live weight, 1065.

Dr. Wm. E. Petersen of the University of Minnesota Dairy Department stated that a cow's weight comprises about 7% blood. Dr. Willard L. Boyd of the University of Minnesota Veterinary Department estimated that about ⅓ of the blood was probably lost. The above weight of blood loss was based on these statements.—W. J. BRECKENRIDGE, *Minnesota Museum of Natural History, University of Minnesota, Minneapolis, Minnesota.*

TAPIRELLA DOWII A SYNONYM

From evidence reaching me I believe most mammalogists are inclined to doubt that two species of *Tapirella* occur in Central America. However no one has gone so far as to establish this fact in literature.

The only characters differentiating *Tapirella dowii* from *Tapirella bairdii* are nothing more tangible than a difference in the ossification of the nasal bones. The difference between the two supposed species can be briefly described as follows: in *bairdii* the nasal bones are well developed, each ossified from a single center, thick at base and articulated with each other for the greater part of their length; in *dowii* the nasal bones are small, thin, each ossified from two centers and separated from each other by an anterior prolongation of the frontals.

Individual variation in the ossification of the nasal bones in *Tapirella* is so extreme that I find it impossible to use these characters as a determining factor. Furthermore all of the characters attributed to both *dowii* and *bairdii* I find clearly displayed in one skull at the American Museum of Natural History. Inasmuch as there are no other visible characters separating *dowii* and *bairdii* I see no alternative but to place *Tapirella dowii* in synonymy under *Tapirella bairdii*, which is the older name.

Dr. Thomas Barbour, at whose suggestion I publish this note, tells me that both Dr. Remington Kellogg and Dr. Wilfred Osgood, as well as himself, have independently reached this same conclusion.—GEORGE G. GOODWIN, *American Museum of Natural History, New York, N. Y.*

THE IDENTITY OF MUS LONGIBARBUS PHILIPPI

Among the numerous names given by Philippi to Chilean mammals, that of *Mus longibarbus* was unmentioned in *The Mammals of Chile* (Zool. Series, Field Mus. Nat. Hist., vol. 30, 1943). This inadvertence has been called to my attention by Dr. Remington Kellogg. On referring to notes made in Santiago I find the name in a list with others of which no type specimens were found in the Chilean National Museum.

Philippi's description and figure (Anal. Mus. Nac., Chile, Zool., ent. 14a, pp. 51–52, pl. XXI, fig. 4, 1900), together with the stated locality (Province of Valdivia), are quite sufficient to indicate that the animal concerned was the common *Akodon* to the several forms of which Philippi gave no less than nineteen names. *Mus longibarbus*, therefore, is a synonym of *Akodon olivaceus brachiotis* Waterhouse 1837.—WILFRED H. OSGOOD, *Chicago Natural History Museum, Chicago, Illinois.*

EQUUS FROM THE PLEISTOCENE OF ILLINOIS

In 1938 the writer published an account of a late Pleistocene fauna obtained from a series of gravel pits in the valley of Pole-cat Creek near Ashmore, Coles County, Illinois. Since then (1942) workmen, opening a new pit in the same locality, found portions of a sacrum and pelvis of *Equus*—the first record of horse from this series of gravels. The bones were found in a gravel deposit of post-Shelbyville age, characterized by numerous larch cones, and considered to be a remnant of a terrace or fan somewhat older than the widespread alluvial gravel beds covering the valley floor that have yielded most of the fossils heretofore found (Galbreath, Geol. Ser., Field Mus. Nat. Hist., vol. 6, pp. 303–313, 1938). However due to the method of removing the gravel from the pits, it is possible that the fragments came from the younger gravel deposits bordering the older "larch cone" gravels.

The fragment of the pelvis, consisting of a portion of the right ilium and acetabular region of the ischium, indicates an animal of unusually large size:

Width of the iliac shaft at its narrowest point	73.0 mm
Thickness of the iliac shaft	36.5 mm
Anterior-posterior diameter of the acetabulum	70.5 mm
Superior lip of the acetabulum to anterior notch of oburator foramen	83.5 mm

Other rather puzzling differences from *Equus* pelves examined are the flatness of the wings of the ilium, and the presence of a distinct ridge of bone bordering the iliac notch. It is doubtful if these characters are of taxonomic importance, but our knowledge of the skeletons of Pleistocene horses is too inadequate to be certain.

The specimens have been presented to the Chicago Natural History Museum, Chicago, Illinois.—Edwin C. Galbreath, *Springfield, Illinois.*

REVIEWS

Swanson, Gustav, Thaddeus Surber, and Thomas S. Roberts. The Mammals of Minnesota. Minnesota Department of Conservation, Technical Bull. no. 2, 108 pp., fronts., illustr., 1945. Free distribution.

This is an almost completely rewritten and slightly enlarged edition of Surber's "The Mammals of Minnesota." In the introductory part of the brochure, three sections have been added, i.e. Fossil Mammals of Minnesota, Economic Importance of Minnesota Mammals, and Collecting Minnesota Mammals. These are all short accounts as are the other general headings. Six species are added to Surber's list. These are *Pipistrellus subflavus, Ursus horribilis, Felis concolor, Thomomys talpoides, Microtus chrotorrhinus,* and *Pitymys pinetorum. Vulpes regalis* is considered a subspecies of *fulva* and *Odocoileus virgultus* is placed in synonymy under *Odocoileus h. hemionus.* The names of all species are those in current usage. Eight of Surber's illustrations are used again; nineteen new ones appear. Under each species, in the systematic catalog, there is a brief description, a statement of distribution in Minnesota, a list of known specimens from Minnesota, and a statement on the subspecies that occur in the state. An important part of the description is the listing of weights of individuals.

A list of type localities of mammals for Minnesota, selected references, and an index to the species complete the booklet. Limitations of space prevented the inclusion of life-history notes for each species, but the selected references will guide the student to the principal sources for that type of information.

Some of the illustrations are not up to standard; others are good. Better illustrative material would have added much to the general appearance of the publication.—William Henry Burt.

Hamilton, William J., Jr. The Mammals of Eastern United States. Comstock Publishing Company. Ithaca, N. Y., pp. 1–432, 184 figs. 1943. Price $4.00.

This book, volume 2 in the series of Handbooks of American Natural History edited and projected by Dr. A. H. Wright and published by the Comstock Publishing Company, is an account of the Recent land mammals occurring in the United States east of the Mississippi River, exclusive of the section of Minnesota east of the river.

In all, 258 kinds (species and subspecies) are treated. This figure is of considerable interest because it indicates that the entire area east of the Mississippi River has been conservative in developing geographic races. In contrast, Grinnell's last review of the mammal fauna of California (1933) lists 460 kinds of mammals as occurring in that state. Twenty-eight of them are Primates, seals and their relatives, and whales and their relatives, leaving a land fauna of 432 kinds. The state of Texas, with its 218 kinds of land mammals, has a diversity of kinds nearly equal to that of the entire Eastern United States. Some genera

occurring west of the Mississippi River are entirely absent to the east of that stream—*Scapanus, Notiosorex, Thomomys, Cratogeomys, Perognathus, Liomys, Dipodomys, Microdipodops, Onychomys, Lemmiscus, Ochotona,* and *Antilocapra,* are a few examples. Conversely, only two of the eastern genera, *Parascalops and Neofiber,* fail to reach beyond the western limits of the area covered by this book. It would appear, then, that the problems of the eastern mammalogists as regards differentiation are relatively more easy to cope with than those of their western coworkers.

The accounts of the different species are well-handled. For each species there is given, first, a brief description, followed by accounts of the subspecies, if any, occurring in the region, together with brief comparative descriptions. Next is a statement regarding distribution, and then a section on habits of the species, including habitat, habits, food, reproduction, and economic importance.

As with many books intended largely for the public at large, this one is limited in its scope and left the present reviewer with the feeling that several omissions detracted from the usefulness to which it might have been put. For example, citations to original descriptions would have been helpful to those interested in systematics, as would have citations to the works of authors referred to in the text to those wishing to read further on particular subjects.

The accounts are well-illustrated with numerous new photographs and with 29 illustrations by E. L. Poole. Keys to genera, numerous distributional maps, a selected bibliography arranged under several headings, and an index to the animals treated add to the value of the book. As a handy reference The Mammals of Eastern United States should find ready acceptance.—WILLIAM B. DAVIS.

Cooley, R. A. and Glen M. Kohls. The Argasidae of North America, Central America and Cuba. The University Press, Notre Dame, Ind., pp. 1-152, 14 pls., 57 figs.

Mammalogists interested in the ectoparasites of mammals will find in this monograph a ready reference to the soft-bodied ticks of North America, several of which are known to be of medical and veterinary importance. Five species of *Ornithodorus,* for example, are proved vectors of relapsing fever; two species can transmit Rocky Mountain spotted fever, and one is known to transmit American Q fever. Native American mammals in many instances serve as reservoirs for all three of these human diseases.

The authors divide the family into four genera—*Argas, Otobius, Ornithodorus,* and *Antricola.* The genus *Ornithodorus* is the most widespread and contains the largest number of species.

For each species is given a synonymy; descriptions of adult, nymph, and larva; statement of distribution and hosts; and comments on its economic importance, along with line drawings of diagnostic characters and a map showing the known distributional records.

Of particular interest to mammalogists is the list of known mammalian hosts of argasid ticks. This includes some 55 species of mammals, largely bats, rodents, and rabbits.—WILLIAM B. DAVIS.

NOTICE

The issues of Volume 26 were issued as follows:

VOL. 26, NO. 1, FEBRUARY 27, 1945
VOL. 26, NO. 2, JULY 19, 1945
VOL. 26, NO. 3, NOVEMBER 14, 1945
VOL. 26, NO. 4, FEBRUARY 12, 1946

RECENT LITERATURE

(Conducted by Gerrit S. Miller, Jr., Remington Kellogg, and Emma M. Charters)

[Reprints of this section may be purchased from the Corresponding Secretary]

ALBRECHT, WM. A. Pattern of wildlife distribution fits the soil pattern. North Dakota Outdoors, Bismarck, vol. 7, no. 7, pp. 12–14. January, 1945.

ALLEN, DURWARD L. Michigan fox squirrel management. Michigan Dept. Conservation, Game Div., Lansing, Publ. 100, pp. 404, illus. 1943.

ANONYMOUS. How baby kangaroos get into the pouch. Animal Kingdom, New York, vol. 47, no. 5, p. 121. September–October, 1944.

——— 1944 Missouri deer season, November 3–4. Missouri Wildlife, St. Louis, vol. 6, no. 4, pp. 10–11, 13. October, 1944.

——— Iowa beaver present example of modern game management. Iowa Conservationist, Des Moines, vol. 3, no. 11, pp. 83–84, illus. November 15, 1944.

——— Buffalo wolf killed near Beach, N. D. North Dakota Outdoors, Bismarck, vol. 7, no. 6, p. 10, illus. December, 1944.

——— The coyote. South Dakota Conservation Digest, Pierre, vol. 11, no. 12, p. 6. December, 1944.

——— Skinning a coyote. South Dakota Conservation Digest, Pierre, vol. 11, no. 12, p. 14. December, 1944.

——— Wapiti, or American elk. South Dakota Conservation Digest, Pierre, vol. 11, no. 12, p. 14. December, 1944.

——— Hermosa Creek elk herd. Colorado Conservation Comments, Denver, vol. 7, no. 4, p. 5. December 15, 1944.

——— The Colobus family album. Nat. Hist., New York, vol. 54, no. 1, pp. 42–43, illus. January, 1945.

——— Small wildlife sanctuaries. Nature Mag., Washington, vol. 38, no. 1, p. 33. January, 1945.

——— Currituck's fur resources. North Carolina Wildlife Conservation, Raleigh, vol. 9, no. 1, pp. 3–7, illus. January–February, 1945.

——— Elk in the wintertime. Montana Wildlife Bull., Helena, vol. 2, no. 1, p. 6, illus. February, 1945.

——— "Recap" of the 1944 deer season. Ohio Conservation Bull., Columbus, vol. 9, no. 2, pp. 4–5. February, 1945.

——— Tree girdling by rabbits. Ohio Conservation Bull., Columbus, vol. 9, no. 2, p. 27, illus. February, 1945.

ANSON, BARRY J., EARL W. CAULDWELL, AND ARTHUR F. REIMANN. Terminal stages in the development of the human stapes. Annals Otol., Rhinol. and Laryngol., St. Louis, vol. 53, no. 1, pp. 12, figs. 7. March, 1944.

ANSON, BARRY J. The great plague of London in literary and medical writings of the period. Quarterly Phi Beta Pi, vol. 41, no. 1, pp. 19, figs. 11. March, 1944.

——— The Fabrica of Andreas Vesalius. Quarterly Phi Beta Pi Med. Fraternity, Spring 1944, pp. 199–209, pls. 5.

——— Conceptions of the structure, function and diseases of the eye in the collected works of Ambroise Paré. Quarterly Bull., Northwestern Univ. Med. School, Chicago, 1944, vol. 18, no. 3, pp. 244–255, figs. 2. Fall, 1944.

ARMYTAGE, J. E., AND A. BOLLIGER. Transmission of kala-azar to the pouch young of the common Australian possum (*Trichosurus vulpecula*). Nature, London, vol. 155, no. 3927, pp. 145–146. February 3, 1945.

ASHBROOK, FRANK G., AND EDNA M. SATER. The increased use of game as a food. Pennsylvania Game News, Harrisburg, vol. 15, no. 8, pp. 7, 28. November, 1944.

BARTLETT, I. H. A comparison of deer seasons—1919 and 1943. Michigan Conservation, Lansing, vol. 13, no. 10, pp. 3, 12. November, 1944.

BASSETT, CHARLES F., AND OLIVER P. PEARSON. Mating fox vixens for maximum productivity. Amer. Fur Breeder, Duluth, vol. 17, no. 8, pp. 16, 18, illus. February, 1945.

BATES, MARSTON. The saimiri monkey as an experimental host for the virus of yellow fever. Amer. Jour. Trop. Med., Baltimore, vol. 24, no. 2, pp. 83–89, figs. 2. March, 1944.

——— Experiments with the virus of yellow fever in marsupials, with special reference to brown and grey masked opossums. Amer. Jour. Trop. Med., Baltimore, vol. 24, no. 2, pp. 91–103, figs. 3. March, 1944.

BAYLIS, H. A. Notes on some parasitic nematodes. Ann. and Mag. Nat. Hist., London, ser 11, vol. 11, no. 84, pp. 793–804. (December, 1944) April 12, 1945. (*Tarsius*, *Loris* and *Suncus*.)

BEACH, FRANK A. Relative effects of androgen upon the mating behavior of male bats subjected to forebrain injury or castration. Jour. Exper. Zool., Philadelphia, vol. 97, no. 3, pp. 259–295, illus. December, 1944.

BEATY, JOHN Y. Some toothy tricks of nature. Nature Mag., Washington, vol. 38, no. 1, pp. 34–35, illus. January, 1945. (Whales.)

BEETZ, HENRY. L'elevage des animaux a fourrure. Quebec, pp. 106, illus. January–February, 1945.

BENGTSON, BENNIE. Tunnelers extraordinary. Fauna, Philadelphia, vol. 6, no. 4, pp. 110–111. December, 1944. (Pocket gopher.)

BOND, CHARLOTTE R. The golden hamster (*Cricetus auratus*): Care, breeding, and growth. Physiological Zool., Chicago, vol. 18, no. 1, pp. 52–59. January, 1945.

BOWNESS, E. RENDLE. The pearl platinum fox. (Continued from December.) Amer. Fur Breeder, Duluth, vol. 17, no. 7, pp. 34–36. January, 1945.

——— Mink mating problems. Amer. Fur Breeder, Duluth, vol. 17, no. 7, pp. 40–44. January, 1945.

——— Some timely suggestions for mink mating. Amer. Nat. Fur and Market Jour., Wausau, vol. 23, no. 7, pp. 5–6. February, 1945.

BRADFORD, HARRY B. Some whale facts. Nature Mag., Washington, vol. 38, no. 2, pp. 99–100, illus. February, 1945.

BRADT, G. W. What about the otter? Michigan Conservation, Lansing, vol. 14, no. 2, pp. 4, 10, illus. February, 1945.

BRENNAN, JAMES M. Field investigations pertinent to Bullis fever. Preliminary report on the species of ticks and vertebrates occurring at Camp Bullis, Texas. Texas Reports on Biology and Medicine, vol. 3, no. 1, pp. 112–121; no. 2, pp. 204–226. 1945. (Mammalian hosts, pp. 218–219.)

BRIGHAM, GEO. D., AND IDA A. BENGTSON. A study of the complement fixation and Weil-Felix reactions in wild rats as related to the isolation of the virus of endemic typhus. U. S. Publ. Health Repts., Washington, vol. 60, no. 2, pp. 29–46. January 12, 1945.

BRYSON, VERNON. Development of the sternum in screw tail mice. Anat. Record, Philadelphia, vol. 91, no. 2, pp. 119–138, figs. 7, pls. 2. February, 1945.

BULLEY, HEBE. Little fur king. Frontiers, Lancaster, vol. 9, no. 3, pp. 67–69, 97, illus. February, 1945. (Chinchilla.)

CAMPBELL, J. E. The raccoon in North Dakota. North Dakota Outdoors, Bismarck, vol. 7, no. 8, p. 4. February, 1945.

CARHART, ARTHUR H. Killing deer by kindness. Amer. Forests, Washington, vol. 51, no. 1, pp. 13–15, 40, illus. January, 1945.

——— What deer eat. By species, by season, by range, and by preference. Amer. Field, Chicago, vol. 143, no. 2, pp. 28–29, illus. January 13, 1945.

CARL, G. CLIFFORD, AND GEORGE A. HARDY. Flora and fauna of the Paradise Mine area, British Columbia. Rept. Prov. Mus. Nat. Hist. and Anthrop. for year 1944, Victoria, pp. C18–C38, pl. 1. 1945. (Mammals, pp. C32–C35).

CARR, WILLIAM H. Whitetails. Nat. Hist., New York, vol. 53, no. 9, pp. 420–424, illus. November, 1944.

——— Gray fox adventures. Nat. Hist., New York, vol. 54, no. 1, pp. 4–9, illus. January, 1945.

CAULDWELL, EARL W., BARRY J. ANSON, AND ROBERT R. WRIGHT. The extensor indicis proprius muscle. A study of 263 consecutive specimens. Quarterly Bull. Northwestern Univ. Med. School, Chicago, 1943, vol. 17, no. 4, pp. 267–279. Winter, 1943.

CLELAND, ALTON. Let sleeping moose lie. Rod and Gun in Canada, Montreal, vol. 45, no. 8, pp. 14–15, illus. February, 1945.

COLE, FAY-COOPER. Some problems of human racial development and migration. Amer. Nat., Lancaster, vol. 79, no. 780, pp. 5–13. January–February, 1945.

COLE, LEON J. Breeding glacier blue and pearlatina foxes. Nat. Fur News, Denver, vol. 17, no. 1, p. 10, February 1945; Amer. Fur Breeder, Duluth, vol. 17, no. 8, p. 24, February 1945; Amer. Nat. Fur and Market Jour., Wausau, vol. 23, no. 7, pp. 9–10, February 1945; Fur of Canada, Winnipeg, vol. 10, no. 1, p. 17, April 1945.

COLLIER, LAURETTE S. Congress and Jackson Hole Monument. Living Wilderness, Washington, vol. 10, whole no. 12, pp. 28–31. February, 1945.

COLLINS, HENRY B., JR., AUSTIN H. CLARK, AND EGBERT H. WALKER. The Aleutian Islands: Their people and natural history (with keys for the identification of the birds and plants). Smithsonian Inst., War Background Studies, Washington, no. 21, pp. 1–131, illus. February 5, 1945. (Mammals, pp. 48–54.)

COWAN, I. McT. Further notes on the winter occurrence of bats in British Columbia. Murrelet, Seattle, vol. 25, no. 3, p. 45. September–December (December 20), 1944.

CRANDALL, LEE S. Two young agoutis. Animal Kingdom, New York, vol. 47, no. 5, p. 125. September–October, 1944.

CROMBIE, A. C. Rat plagues in western Queensland. Nature, London, vol. 154, no. 3921, pp. 803–804. December 23, 1944.

DAILEY, E. J. Little river beaver. An account of some spring beaver trapping during 1944. Fur-Fish-Game (Harding's Mag.), Columbus, vol. 79, no. 2, pp. 30–32. February, 1945.

DAVIDSON, CARL E. Bears prowl Kodiak Island. Sports Afield, Minneapolis, vol. 112, no. 4, pp. 38–40, 59–65, illus. October, 1944.

DAVIS, WILLIAM B. Texas bats. Texas Game and Fish, Austin, vol. 3, no. 2, pp. 4–5, 12–13, illus. January, 1945.

DITTOE, GEORGIA B. Neighbors in nature. San Diego Zoonooz, vol. 18, no. 2, pp. 5, 6, illus. February, 1945. (Ocelot, jaguarondi.)

DIXON, JOSEPH S., AND CARLTON M. HERMAN. Studies on the condition of California mule deer at Sequoia National Park. California Fish and Game, San Francisco, vol. 31, no. 1, pp. 3–11, illus. January, 1945.

DOBIE, J. FRANK. Strange animal friendships. Nature Mag., Washington, vol. 38, no. 1, pp. 9–12, illus., January 1945; South Dakota Conservation Digest, Pierre, vol. 12, no. 2, pp. 2–3, 15. February 1945.

DUFRESNE, FRANK. White bear. Field and Stream, New York, vol. 49, no. 10, pp. 16–17, 64–66, illus. February, 1945.

DURHAM, J. WYATT. Megafaunal zones of the Oligocene of northwestern Washington. Univ. California Publ., Bull. Dept. Geol. Sci., Berkeley, vol. 27, no. 5, pp. 101–211. November 14, 1944.

DYKES, JACK, AND BARRY J. ANSON. The accessory tendon of the flexor pollicis longus muscle. Anat. Record, Philadelphia, vol. 90, no. 1, pp. 83–87, figs. 2. September, 1944.

EAST, BEN. Wildcat in the rain. Field and Stream, New York, vol. 49, no. 9, pp. 32–34, 70–72, illus. January, 1945.

——— Last crack at snowshoes. Field and Stream, New York, vol. 49, no. 10, pp. 30–32, 78–79, illus. February, 1945.

EDMINSTER, FRANK C. Ditching for muskrats. League of Maryland Sportsmen, Rally Sheet, Baltimore, vol. 3, no. 2, p. 5. February, 1945.

ELIAS, HANS. Comparative histology of domestic animals. I. The digestive system. 1. The oral cavity. Middlesex Veterinarian, Waltham, vol. 4, no. 1, pp. 18–22, fig. 1, pls. 2. Winter, 1944.

——— Comparative histology of domestic animals. I. The digestive system. 2. The stomach of domestic mammals. Middlesex Veterinarian, Waltham, vol. 4, no. 2, pp. 66–69, pl. 1. Spring-Summer, 1944.

ELLEY, W. B. Proper care of beaver pelts. South Dakota Conservation Digest, Pierre, vol. 12, no. 1, p. 13, illus. January, 1945.

ELWELL, NISKA. Albino animals of the North. Field and Stream, New York, vol. 49, no. 9, pp. 86–87, illus. January, 1945.

ELWONGER, RUTH. A bat reports. Frontiers, Philadelphia, vol. 9, no. 2, pp. 46–47, 54. December, 1944.

ERICKSON, LYNN. Fur eating in chinchillas. Nat. Fur News, Denver, vol. 16, no. 12, pp. 12, 17, 37. January, 1945.

ERRINGTON, PAUL L. [Review of] The wolves of North America, by Stanley P. Young and Edward A. Goldman. Ecology, Lancaster, vol. 26, no. 1, p. 108. January, 1945.

FAIRCHILD, HOMER E., AND GEORGE O. HENDRICKSON. Behavior and food of penned raccoons. Iowa Conservationist, Des Moines, vol. 4, no. 2, p. 112, illus. February 15, 1945.

FARRINGTON, KIP. The dandy dolphin. Field and Stream, New York, vol. 49, no. 9, pp. 74–75, illus. January, 1945.

FOX, B. C. Beaver in Arizona. Arizona Wildlife and Sportsman, Safford, vol. 6, no. 10, p. 10, illus. October, 1944.

FRASER, ALEXANDER. Kipawa deer and the wolves. Rod and Gun in Canada, Montreal, vol. 45, no. 8, pp. 7, 33, illus. February, 1945.

GABRIELSON, IRA N. Controlling rodents and other small animal pests in Oregon. Oregon Extension Bull., Corvallis, no. 629, pp. 1–23, illus. 1944.

GERBER, EDUARD. Über einen Humerus des wollhaarigen Nashorns aus der Niederterrasse von Roggwil. Eclogae Geol. Helvetiae, Basel, vol. 34, no. 2, pp. 277–279. March 7, 1942.

GHOSH, GAURCHANDRA. Rat control. Sci. and Culture, Calcutta, vol. 10, no. 8, pp. 344–346, fig. 1. February, 1945. (Rats involved in spread of plague, rat-bite fever, spirochaete-caused infectious jaundice, trichinosis, tape-worm and Salmonella enteritidis-caused infection. *Mus musculus*, *Rattus rattus rattus*, *R. r. alexandrinus*, and *R. norvegicus* are common forms.)

GOLDMAN, E. A. A new cacomistle from Guerrero. Proc. Biol. Soc. Washington, vol. 58, pp. 105–106. July 18, 1945. (New: *Bassariscus astutus bolei*.)

GOODE, MONROE H. "Nutcracker suite". Sports Afield, Minneapolis, vol. 112, no. 4, pp. 30–31, 74, 77–79, illus. October, 1944. (Squirrels.)

GORDON, KENNETH. The natural history and behavior of the western chipmunk and the mantled ground squirrel. Oregon State Monogr., Corvallis, Studies in Zool., no. 5, pp. 1–104. 1943.

GRIESBACH, W. E., T. H. KENNEDY, AND H. D. PURVES. Protective action of potassium iodide on thiourea poisoning in rats. Nature, London, vol. 154, no. 3915, pp. 610–611. November 11, 1944.

GRIGG, J. CURTIS. Muskrat hints. Outdoorsman, Chicago, vol. 87, no. 1 (whole no. 512), pp. 42, 44, illus. January–February, 1945.

GRIMM, WM. C. Analysis of the late fall and early winter muskrat population in northwestern Pennsylvania. Pennsylvania Game News, Harrisburg, vol. 15, no. 10, pp. 12–13, illus. January, 1945.

GRUBBS, CLARENCE S. The mink feeding problem. Nat. Fur News, Denver, vol. 17, no. 1, pp. 9, 23. February, 1945.

GUNN, C. K. Fox rations in the breeding season. Nat. Fur News, Denver, vol. 16, no. 12, p. 7. January, 1945.

——— Preliminary note on the treatment of anemia in mutant fox pups. Fur of Canada, Winnipeg, vol. 10, no. 5, pp. 14–15, illus. February, 1945.

HAMPE, IRVING E. Maryland nature log. The squirrels of Maryland. Maryland Conservationist, Baltimore, vol. 21, no. 3, p. 11. Summer and Fall Issue, 1944.

HARDY, ROSS. The influence of types of soil upon the local distribution of some mammals in southwestern Utah. Ecol. Monogr., Durham, vol. 15, pp. 71–108, figs. 19. January, 1945.

HARRINGTON, LYN. The masked bandit of the woods. Canadian Nature, Toronto, vol. 6, no. 5, pp. 154–155, illus. November–December, 1944. (Raccoon.)

HARRIS, RAY. Mice by the million. A farmer's tribulations in the wheat belt. Wildlife, Australian Nature Mag., Melbourne, vol. 7, no. 1, pp. 9–11, illus. January, 1945.

HAWKES, J. LARRY. Preparing game and fish. Alabama Conservation, Montgomery, vol. 16, no. 6, pp. 7, 14, illus. December, 1944.

HEDGPETH, JOEL W. Sea lions. Nature Mag., Washington, vol. 37, no. 8, pp. 443, 445. October, 1944.

HERMAN, CARLTON M. Hippoboscid flies as parasites of game animals in California. California Fish and Game, San Francisco, vol. 31, no. 1, pp. 16–25, illus. January, 1945. (Deer, antelope.)

HIBBARD, CLAUDE W., AND LESTER F. PHILLIS. The occurrence of Eucastor and Epigaulus in the lower Pliocene of Trego County, Kansas. Univ. Kansas Sci. Bull., Lawrence, vol. 30, pt. 2, no. 16, pp. 549–555, figs. 3. June 15, 1945. (New: *Epigaulus minor*.)

HILL, JOHN ERIC. Singing mice. Nat. Hist., New York, vol. 53, no. 10, p. 436. December, 1944.

HITCHCOCK, HAROLD B. Banding as an aid in studying the activities of the little brown bat, *Myotis lucifugus lucifugus*. Michigan Acad. Sci., Arts, and Letters, Ann Arbor, vol. 29, pp. 277–279. 1943 (1944).

HYNES, J. Cottontail lore. Field and Stream, New York, vol. 49, no. 7, pp. 34–35, 80–82. November, 1944.

JACKSON, HARTLEY H. T. Big-game resources of the United States, 1937–1942. U. S. Dept. Interior, Fish and Wildlife Service, Research Rept. no. 8, pp. 1–56, figs. 31. (1944) January, 1945.

KOBY, F. EDOUARD. Note sur la patte de Felis spelaea Goldf. Eclogae Geol. Helvetiae, Basel, vol. 34, no. 2, p. 319. March 7, 1942.

KOLB, C. HAVEN. Little known neighbors. Maryland, A journal of natural history, Baltimore, vol. 14, no. 4, pp. 93–96. October, 1944. (White-footed, meadow, and pine mice.)

KREFTING, LAURITS, AND ALTON BRAMER. Wildlife conservation at Grand Portage. Indians at Work, U. S. Dept. Interior, Chicago, vol. 12, no. 3, pp. 19–21, illus. September–October, 1944.

LAMMON, L. D. Three deer, two moose, one caribou—that was the limit! Minnesota Div. Bull. Isaak Walton League, p. 19. 4th quarter, 1944.

L[AMSTER], E. R. The cottontail rabbit. South Dakota Conservation Digest, Pierre, vol. 11, no. 12, p. 12. December, 1944.

——— The muskrat. South Dakota Conservation Digest, Pierre, vol. 12, no. 1, p. 12. January, 1945.

——— Coyote hunt at Gettysburg. South Dakota Conservation Digest, Pierre, vol. 12, no. 1, pp. 11, 15, illus. January, 1945.

LARRISON, EARL J. An early spring reconnaissance of the birds and mammals of Northrup Canyon, Upper Grand Coulee, Washington. Murrelet, Seattle, vol. 25, no. 3, pp. 25–42. September–December (December 20), 1944.

LAWRENCE, BARBARA. Three new Pteropus from New Caledonia and the Solomons. Proc. New England Zoöl. Club, Cambridge, vol. 23, pp. 59–69. March 26, 1945. (New: *Pteropus austini*, *P. rayneri monoensis*, *P. anetianus aorensis*.)

LEISTER, CLAUDE W. Just bear facts. Fauna, Philadelphia, vol. 6, no. 4, pp. 102–109, illus. December, 1944.

LONGTAIL, JOEY. The opossum pest and its friendly predator, the trapper. Forest and Bird, Wellington, no. 75, pp. 2–3. February, 1945.

MAHAFFEY, JUANITA. Whitetails on the move! Oklahoma Game and Fish News, Oklahoma City, vol. 1, no. 1, pp. 3–6, illus. January, 1945.

MANN, F., GUILLERMO. Dos nuevas especies de roedores. Biologica, Trabajos Inst. Biol. Univ. Chile, Santiago, fasc. 1, pp. 95–113, figs. 7, pls. 1–12. September, 1944. (New: *Euneomys noei*, *Phyllotis wolfhuegeli*.)

———— El cerebro de Marmosa elegans. Bol. Mus. Nac. Hist. Nat., Santiago, vol. 22, pp. 197–235, figs. 9, pls. 10. 1944.

MATHESON, COLIN. The domestic cat as a factor in urban ecology. Jour. Anim. Ecol., London, vol. 13, no. 2, pp. 130–133. November, 1944.

MCKEAN, WM. T. Winter deer problem. South Dakota Conservation Digest, Pierre, vol. 12, no. 1, pp. 2–3, 6. January, 1945.

MILLER, GERRIT S., JR. Bats: Mammals that fly. The World is Yours, Smithsonian Inst. Radio Program, vol. 1, no. 37, pp. 1–13. June 17, 1940.

MILLER, RICHARD G. Food habits of Yosemite mammals as indicated by their teeth. Pt. 1. Yosemite Nature Notes, vol. 24, no. 2, pp. 33–36, illus. February, 1945.

MOOJEN, J. Capivaras. Rev. Mus. Nac., Rio de Janeiro, Ano 1, no. 1, p. 16, col. pl. August, 1944.

MORAIS REGO, AURORA RAMOS DE. O peixe-boi. Rev. Mus. Nac., Rio de Janeiro, Ano 1, no. 2, pp. 10–12, figs. 2. December, 1944. (Manatee.)

[MORRISON, P. CROSBIE, EDITOR.] Mouse plagues past and future. Wildlife, Australian Nature Mag., Melbourne, vol. 7, no. 1, pp. 11–13, illus. January, 1945. (36,000,000 mice, more than 600 tons, trapped in Victorian wheat areas in autumn of 1917.)

MUENCH, JOYCE, AND JOSEF MUENCH. Monarch of the pass. Frontiers, Lancaster, vol. 9, no. 3, pp. 80–82, illus. February, 1945. (Mule deer.)

MULLIGAN, R. M. Quantitative studies on the blood and bone marrow of newborn mongrel puppies. Anat. Record, Philadelphia, vol. 91, no. 2, pp. 161–167. February, 1945.

MUNRO, GEORGE C. Tragedy in bird life. Elepaio, Jour. Honolulu Audubon Soc., vol. 5, no. 8, pp. 48–51. February, 1945. (Rat depredations.)

MURIE, ADOLPH. The wolves of Mount McKinley. Living Wilderness, Washington, vol. 10, no. 12, pp. 9–25, illus. February, 1945.

MURIE, OLAUS J. Alaska. Living Wilderness, Washington, vol. 10, whole no. 12, pp. 3–8, illus. February, 1945. (Caribou, bear, etc.)

MURPHY, ROBERT CUSHMAN. Wet lands and dry seas. Nat. Hist., New York, vol. 53, no. 8, pp. 350–356, illus. October, 1944. (Whales, blackfish, etc., off coast of Colombia.)

NELSON, URBAN C. Losses of crippled deer. Conservation Volunteer, St. Paul, vol. 7, no. 43, pp. 34–35. November–December, 1944.

NICKLES, BILL. Our bobcats. Shenandoah, Luray, vol. 2, no. 1, pp. 11–13. Autumn, 1937. (Formerly "Shenandoah Nature Journal.")

NIEHUIS, CHAS. C. Data on elk and antelope hunting. Arizona Wildlife and Sportsman, Safford, vol. 6, no. 10, p. 8. October, 1944.

NISSEN, HENRY W. The ape colony in Florida. Animal Kingdom, New York, vol. 47, no. 6, pp. 137–142, illus. November–December, 1944.

O'CONNOR, JACK. The Arizona whitetail. Arizona Wildlife and Sportsman, Tucson, vol. 6, no. 4, p. 10. February, 1945.

OEHSER, PAUL H. [Review of] The wolves of North America, by Stanley P. Young and Edward A. Goldman. Scientific Monthly, Lancaster, vol. 59, no. 6, pp. 478–479. December, 1944.

ORMOND, CLYDE. Try coyotes. Field and Stream, New York, vol. 49, no. 10, pp. 24–25, 94–95, illus. February, 1945.

ORR, ROBERT T. Communal nests of the house mouse (Mus musculus Linnaeus). Wasmann Collector, San Francisco, vol. 6, no. 2, pp. 35–37. November, 1944.

OSBORN, S. S. My experimental work with mink mutations. Amer. Fur Breeder, Duluth, vol. 17, no. 7, pp. 30–32, illus. January, 1945.

——— Mutation mink types. Nat. Fur News, Denver, vol. 17, no. 1, pp. 7, 26. February, 1945.

OSGOOD, WILFRED H. Biographical memoir of Clinton Hart Merriam 1855–1942. Nat. Acad. Sci., Washington, Biogr. Mem., vol. 24, mem. 1, pp. 1–57, photo. 1945.

PARK, ORLANDO. Observations concerning the future of ecology. Ecology, Lancaster, vol. 26, no. 1, pp. 1–9. January, 1945.

PARKER, R. R. Tularemia: Spontaneous occurrence in the chipmunk. U. S. Publ. Health Repts., Washington, vol. 60, no. 1, p. 17. January 5, 1945.

PARKS, T. H. Rat control. Ohio State Univ., Columbus, Agric. Extension Serv. Bull., no. 245, 4 pp., illus. November, 1943.

PEABODY, FRANK E. An occurrence of late Pleistocene mammals in the San Francisco peninsula. Jour. Paleontol., Chicago, vol. 19, no. 1, pp. 60–63, fig. 1. January, 1945.

PERRY, CLAY. Beaver crisis in the northeast. Amer. Forests, Washington, vol. 51, no. 2, pp. 72–73, 94–95, illus. February, 1945.

PICK, JAMES W., BARRY J. ANSON, AND HARRY W. BURNETT, JR. Communication between lymphatic and venous system at renal level in man. Quarterly Bull., Northwestern Univ. Med. School, Chicago, 1944, vol. 18, no. 4, pp. 307–316, figs. 2. Winter, 1944.

PIKE, OLIVER G. Bats. Nature, London, vol. 155, no. 3926, p. 122, illus. January 27, 1945.

POCOCK, R. I. The premaxillae in the Asiatic rhinoceroses. Ann. and Mag. Nat. Hist., London, ser. 11, vol. 11, no. 84, pp. 834–842. December, 1944.

POGOGEFF, IRENE A., AND MARGARET R. MURRAY. Degeneration of adult mammalian skeletal muscle in vitro. Science, Lancaster, n.s., vol. 101, no. 2616, p. 174. February 16, 1945.

POOR, HARRY W. Moose wander far. Bull. Massachusetts Audubon Soc., Boston, vol. 29, no. 1, pp. 21–22, illus. February, 1945.

PREBLE, EDWARD A. North American marten. Nature Mag., Washington, vol. 38, no. 1, p. 32, illus. January, 1945.

RAND, A. L. Mammal investigations on the Canol Road, Yukon and Northwest Territories, 1944. Bull. 99 (Biol. Ser. No. 28), Nat. Mus. Canada, Ottawa, pp. 1–52, fig. 1 (map), pls. 20. 1945. (New: *Microtus andersoni*.)

——— Mammals of Yukon, Canada. Bull. 100 (Biol. Ser. no. 29), Nat. Mus. Canada, Ottawa, pp. 1–93, figs. 27. 1945.

REIMANN, ARTHUR F., AND BARRY J. ANSON. Vertebral level of termination of the spinal cord with report of a case of sacral cord. Anat. Record, Philadelphia, vol. 88, no. 1, pp. 127–138, figs. 7. January, 1944.

REIMANN, ARTHUR F., EDWARD H. DASELER, BARRY J. ANSON, AND LINDSAY E. BEATON. The palmaris longus muscle and tendon. A study of 1600 extremities. Anat. Record, Philadelphia, vol. 89, no. 4, pp. 495–505, figs. 3. August, 1944.

RIGGS, E. S. A rare cameloid from the late Pleistocene sands of southwestern Kansas. Trans. Kansas Acad. Sci., Topeka, vol. 48, no. 1, pp. 101–104, fig. 1. 1945. (*Eschatius conidens* Cope.)

ROEBUCK, A., F. T. BAKER, AND J. H. WHITE. The grazing of winter cereals by the woodmouse (*Apodemus sylvaticus*). Jour. Anim. Ecol., London, vol. 13, no. 2, pp. 105–109, pls. 1–2. November, 1944.

ROWAN, WILLIAM. Bandits by nature. Fauna, Philadelphia, vol. 6, no. 4, pp. 99–101, illus. December, 1944. (Bears.)

RUSH, WILLIAM MARSHALL. Lady of leisure. Fauna, Philadelphia, vol. 6, no. 4, pp. 114–118, illus. December, 1944. (Cougar.)

——— Beau Brummel of the wild. Nat. Hist., New York, vol. 54, no. 1, pp. 40–41, fig. 1. January, 1945. (Kangaroo rat.)

SCHAUB, SAMUEL. Die kleine Hirschart aus dem Oberpliocaen von Senèze (Haute-Loire). Eclogae Geol. Helvetiae, Basel, vol. 34, no. 2, pp. 264–271, fig. 1, pl. 17. March 7, 1942. (New: *Cervus philisi*.)

——— Ein neues Hyaenidengenus von der Montagne de Perrier. Eclogae Geol. Helvetiae, Basel, vol. 34, no. 2, pp. 279–286, pls. 18–20. March 7, 1942. (New: *Euryboas bielawskyi*.)

SCHERMERHORN, JACQUELINE. Curious cat. San Diego Zoonooz, vol. 17, no. 12, pp. 3–4, illus. December, 1944. (Capybara, anteater.)

——— Just plain Ham. San Diego Zoonooz, vol. 18, no. 1, pp. 3–4, illus. January, 1945. (Baboon.)

——— Animated dishmops. San Diego Zoonooz, vol. 18, no. 2, pp. 6–7, illus. February, 1945. (Orang-utan.)

SCHULTZ, ADOLPH H. Biographical memoir of Ales Hrdlicka 1869–1943. Nat. Acad. Sci., Biogr. Mem., Washington, vol. 23, mem. 12, pp. 305–338, photo. 1945.

SCHWARTZ, CHAS. W. The cottontail in Missouri. Missouri Conservationist, Jefferson City, vol. 6, no. 1, pp. 8–9, illus. January, 1945.

SCOTT, WILLIAM B. The Mammalia of the Duchesne River Oligocene. Trans. Amer. Philos. Soc., Philadelphia, n.s., vol. 34, pt. 3, pp. 209–253, pls. 8. March, 1945. (New: *Eosictis, E. avinoffi, Diplobunops crassus, Protoreodon tardus, Megalamynodon, M. regalis*.)

SHAMEL, H. HAROLD. A new Eptesicus from Jamaica. Proc. Biol. Soc. Washington, vol. 58, pp. 107–110. July 18, 1945. (New: *Eptesicus lynni*.)

SHARPLES, WYNNE. The histogenesis of the argentaffin cells in the stomach and duodenum of the rat. Anat. Record, Philadelphia, vol. 91, no. 2, pp. 107–114, pls. 2. February, 1945.

SHAW, WILLIAM T. Seasonal and daily activities of the Columbian ground squirrel at Pullman, Washington. Ecology, Lancaster, vol. 26, no. 1, pp. 74–84, illus. January, 1945.

SHERMAN, H. B. A new subspecies of Geomys from Florida. Proc. New England Zool. Club, Cambridge, vol. 23, pp. 37–40. August 30, 1944. (New: *Geomys tuza goffi*.)

——— Recent literature and some new distribution records concerning Florida mammals. Proc. Florida Acad. Sci., Gainesville, vol. 7, nos. 2–3, pp. 199–202. 1944 (1945).

——— The Florida yellow bat, *Dasypterus floridanus*. Proc. Florida Acad. Sci., Gainesville, vol. 7, nos. 2–3, pp. 193–197. 1944 (1945).

SILBERBERG, MARTIN, AND RUTH SILBERBERG. The influence of sex and breeding on skeletal ageing of mice. Anat. Record, Philadelphia, vol. 91, no. 2, pp. 89–101, pls. 2. February, 1945.

SILVA, JOÃO AUGUSTO. Animais selvagens. Contribuïção para o estudo da fauna cinegética de Moçambique. (Continuação do no. 30). Moçambique documentário trimestral, Lourenço Marques, No. 40, pp. 49–68, illus. December, 1944.

SNOW, HOMER F. Perpetual appetite. Nature Mag., Washington, vol. 38, no. 1, pp. 17–18, illus. January, 1945. (Hyena.)

SNYDER, L. L. Bears. Canadian Nature, Toronto, vol. 7, no. 1, pp. 20–25, illus. January–February, 1945.

STAVIARSKI, VITOR. Em busca de um fósil. Rev. Mus. Nac., Rio de Janeiro, Ano 1, no. 2, pp. 17–24, figs. 6. December, 1944. (Megatherium found in Parana, Brazil.)

STEBLER, A. M. Fox and coyote trapping simplified. Michigan Dept. Conservation, Lansing, 15 pp. 1944.

STEHLIN, HANS GEORG, AND JOHANNES HÜRZELER. Ein weiterer Paarhufer mit fünffingriger Vorderextremität aus dem europäischen Oligocaen. Eclogae Geol. Helvetiae, Basel, vol. 34, no. 2, pp. 272–277, figs. 5. March 7, 1942.

STEHLIN, HANS GEORG. Eine interessante Phase in den Wandlungen unserer pleistocaenen Säugetierfauna. Eclogae Geol. Helvetiae, Basel, vol. 34, no. 2, pp. 287–291. March 7, 1942.

STOCKING, HOBART E. The camel brigade. Nat. Hist., New York, vol. 53, no. 9, pp. 396–397, 431–433, illus. November, 1944.

STOTT, KEN, JR. The fox who flies. San Diego Zoonooz, vol. 18, no. 1, pp. 5–6, illus. January, 1945.

SWANSON, GUSTAV, THADDEUS SURBER, AND THOMAS S. ROBERTS. The mammals of Minnesota. Minnesota Dept. Conservation, St. Paul, Tech. Bull. no. 2, pp. 108, illus. 1945.

TATE, G. H. H. Results of the Archbold expeditions. No. 52. The marsupial genus *Phalanger*. Amer. Mus. Novitates, New York, no. 1283, pp. 41, figs. 9. April 27, 1945. (New: *Phalanger orientalis peninsulae*, *P. celebensis pelengensis*, *P. atrimaculatus*, *P. ursinus togianus*.)

——— Results of the Archbold expeditions. No. 54. The marsupial genus *Pseudocheirus* and its subgenera. Amer. Mus. Novitates, New York, no. 1287, pp. 30, figs. 5. June 11, 1945. (New: *Pseudocheirus herbertensis cinereus*.)

TEALE, EDWIN WAY. Beaver show. Nat. Hist., New York, vol. 53, no. 9, pp. 390–395, illus. November, 1944.

THOMPSON, RAYMOND. Crafty coyotes. Outdoorsman, Chicago, vol. 87, no. 1 (whole no. 512), pp. 18–19, 24–25, illus. January–February, 1945.

——— The war and trapping. Fur-Fish-Game (Harding's Mag.), Columbus, vol. 79, no. 2, pp. 10–11, 21. February, 1945.

TOWERS, IRVING L. Notes on mammal sperms. Maryland, Baltimore, vol. 14, no. 4, pp. 83–90. October, 1944.

TROUGHTON, ELLIS. Furred animals of Australia. Angus and Robertson Ltd., Sydney, 2d (revised) ed., pp. xxvii + 374, pls. 25 (colored). November, 1943. (New: *Registrellus* for *Pipestrellus* [sic] *regulus* Thomas; *Falsistrellus* for *Vespertilio tasmaniensis* Gould; *Scoteanax* for *Nycticejus ruppellii* Peters; *Scotorepens* for *Scoteinus orion* Troughton.)

ULMER, FREDERICK A., JR. On the trail of the wood rat. Fauna, Philadelphia, vol. 6, no. 4, pp. 112–113, illus. December, 1944.

VINOGRADOV, B. S., AND A. I. ARGYROPULO. Faune de l'URSS. Mammifères. Tableaux analytiques des rongeurs. Inst. Zool. Acad. Sci. URSS, Moscou and Leningrad, n.s., no. 29, pp. 1–241, figs. 109. 1941.

VIOLA, HANS. Some points about mink breeding. Fur of Canada, Winnipeg, vol. 10, no. 5, p. 18. February, 1945.

VOGT, GUILLERMO. El hombre y la tierra. Biblioteca Enciclopedica Popular, Mexico, 32, pp. 1–95. 1944. (Buffalo.)

WALFORD, LIONEL A. [Editor]. Fishery resources of the United States of America. U. S. Dept. Interior, Fish and Wildlife Serv., Washington, pp. 1–135, illus. 1945. (The fur seal resource, pp. 37–38.)

WESTOLL, T. S. New light on the mammalian ear ossicles. Nature, London, vol. 154, no. 3920, pp. 770–771. December 16, 1944.

——— The mammalian middle ear. Nature, London, vol. 155, no. 3926, pp. 114–115, illus. January 27, 1945.

WHEWELL, C. S., AND H. J. WOODS. A reversible contraction phenomenon in animal hairs. Nature, London, vol. 154, no. 3913, p. 546. October 28, 1944.

WILSON, IVAN T. Antelope vs. predators. Arizona Wildlife and Sportsman, Safford, vol. 6, no. 10, p. 11. October, 1944.

YEAGER, LEE E. Cottontails, cane cutters, and jack—all in Illinois. Illinois Conservation, Springfield, vol. 10, no. 1, pp. 7, 37. Winter Issue, 1945.

YOUNG, STANLEY P. Mountain lion trapping. U. S. Dept. Interior, Fish and Wildlife Serv., Circular 6, pp. 7, figs. 4. 1945.

YOUNG, STANLEY P., AND HAROLD W. DOBYNS. Coyote control by means of den hunting. U. S. Dept. Interior, Fish and Wildlife Serv., Circular 7, pp. 8, figs. 2. 1945.

ZIMMERMAN, LEO M., BARRY J. ANSON, EDWARD H. MORGAN, AND CHESTER B. MCVAY. Ventral hernia due to normal banding of the abdominal muscles. Surgery, Gynecology and Obstetrics, Chicago, vol. 78, pp. 535–540, figs. 4. May, 1944.